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## For the Comfort of the Guest

AIR WASHING AND REFRIGERATING FOR EQUIPMENT FOR HOTEL DESHLER; DIRECT AND INDIRECT STEAM HEATING SYSTEMS EMPLOYED

WITH THE ADVANCE and progress brought to the peoples of this world by the hand of civilization, there have come to the individual conveniences and comforts heretofore unknown and things which but yesterday were luxuries are today quite frequently regarded as the necessities of our modern life. This is particularly evident in the development of hotel service, especially that of the majority of hotels in our larger cities where provision is made to meet the every possible want and desire of the most fastidious and that with the greatest convenience and comfort to the guest. And while much of the credit for the service rendered the traveler of today is due to improved methods of hotel management, it is doubtful whether the modern large city hotel would be any more inviting than the small village inn of 50 yr. ago had not these institutions adopted as rapidly as they became practicable the many developments in the fields of mechanical and electrical engineering.

Typical of the modern moderate sized hotel is the new Deshler of Columbus, O., a 12-story structure which, with its 465 guest rooms was but about one year ago thrown open to the public. Nothing has been left

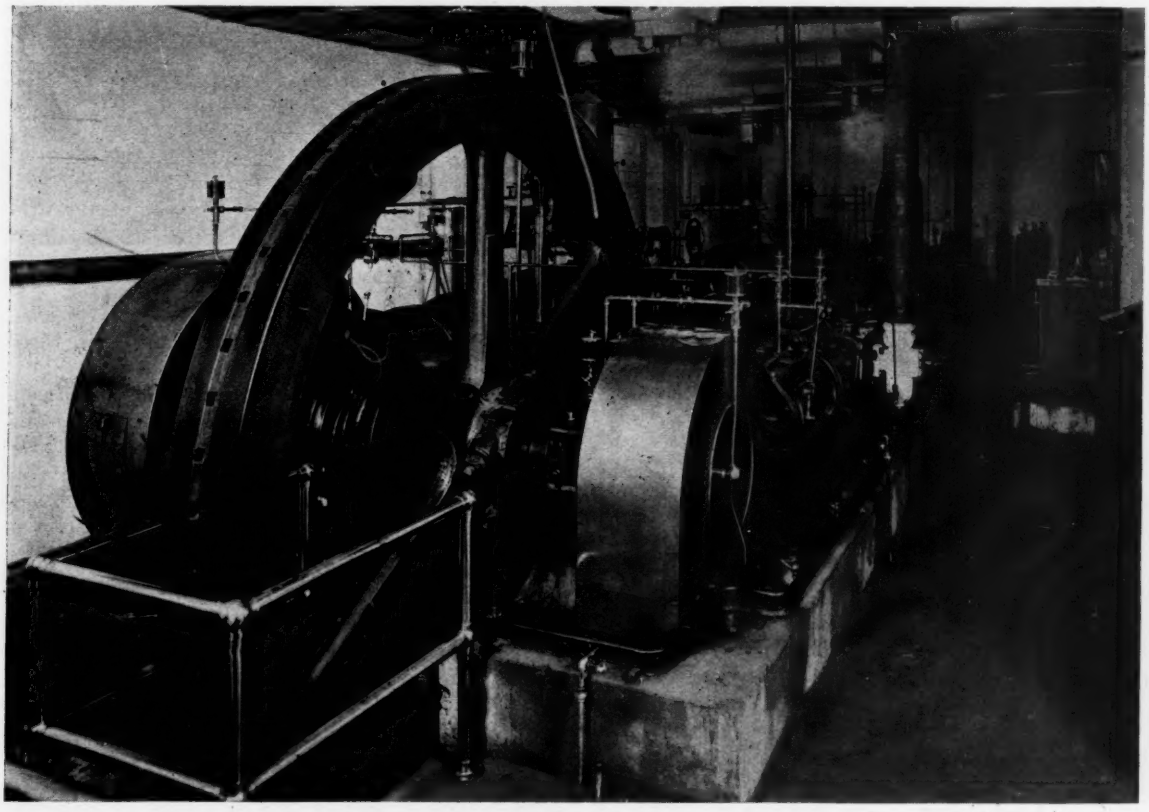

FIG. 1. INTERIOR OF COMPRESSOR ROOM, HOTEL DESHLER

undone to satisfy the needs and wants of the most discriminating and as may be therefore naturally expected, in order to meet the diversified requirements of such an institution, there has been installed a most complete equipment for the proper lighting, heating, ventilation and refrigeration of the building. The major portion of this has been placed in the southwest corner of the basement, and while electric current for light and power

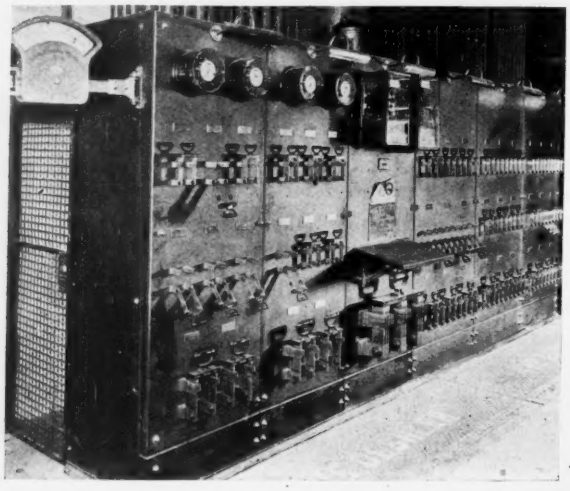

FIG. 2. ELECTRIC DISTRIBUTION BOARD

is at the present time being purchased from the local public service company, the plant as it is, embodies many interesting features. And, as indicated in Fig. 5, the section of the basement housing this equipment is divided into two rooms, in one of which is found the steam generating equipment, and the refrigerating machinery, while in the other adjoining this is the main

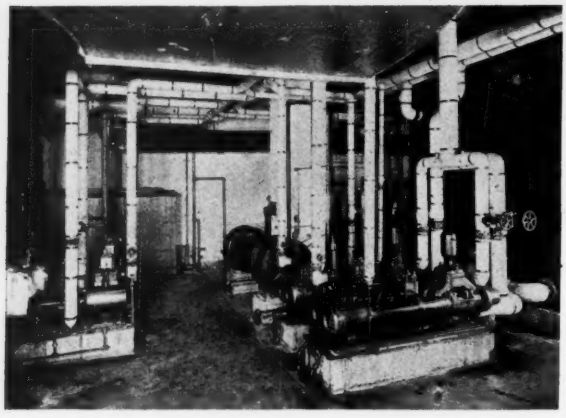

FIG. 3. PUMP AND CONDENSER ROOM

switchboard, the brine tanks, ice-making tanks, condensers, air washing equipment and pumps.

### STEAM GENERATING EQUIPMENT

STEAM for the operation of the compressors and pumps and that used for heating and domestic purposes is generated by a battery of two Scotch Marine type boilers of Freeman make, each having a rating of 250 hp., and designed and built to withstand a maximum working pressure of 150 lb. gage. They are provided with hand-fired Chicago down-draft furnaces and are equipped with smoke recorders, thereby enabling the operators not only to comply more readily with the local smoke ordinances, but also to operate their furnaces at the highest degree of efficiency. As a further aid toward this end, an Ellison draft gage has been installed and so connected as to obtain draft readings at the base of the stack, in the breeching and in the combustion chamber of each boiler.

Cleaning of the boiler flues and other surfaces exposed to the products of combustion is done entirely by means of Diamond soot blowers provided for the purpose.

Feed makeup is taken from the local water mains and together with the heating returns, which are discharged into a 4 by 8-ft. receiving tank having a capacity of about 750 gal., are passed through an open feedwater heater in which the temperature is raised to approximately 210 deg. F. From here it is delivered to the boiler by one of two Worthington vertical steam-driven pumps. These, as also the feed heater, are

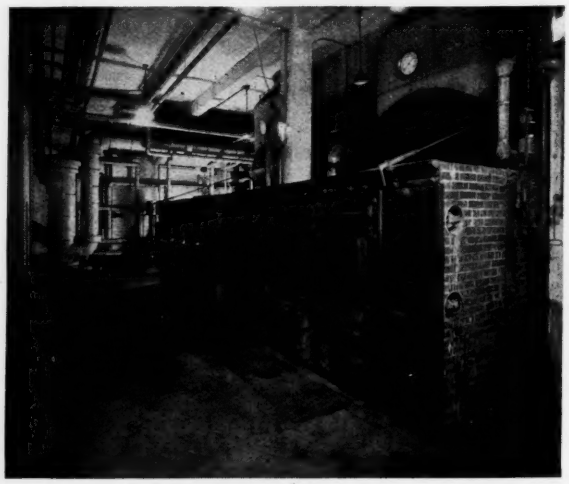

FIG. 4. BOILER ROOM SHOWING FEED WATER HEATER AND PUMPS IN REAR

located in the boiler room, as may be noted in Figs. 4 and 5.

Coal is delivered by trucks and wagons and dumped from above into two storage bins, having a combined capacity of approximately 75 tons.

Ashes as removed from the furnaces are raked into receiving hoppers and transferred to a 10-ton storage bin by means of a steam jet ash conveyor. From this bin they are removed at regular intervals.

### ELECTRICAL EQUIPMENT

NO ELECTRIC CURRENT is generated, all of that used being obtained from the mains of the local public service company and delivered by means of three-wire feeders at a voltage of 220 for distribution through a 2400-amp., three-pole knife switch mounted on the service panel of the six-panel black slate switchboard shown in Fig. 2. In addition, this board also carries 16 single-throw, double-pole knife switches for the control of the lighting circuits, 27 double-pole, single-throw knife switches con-

trolling the power circuits, two totalizing Thomson integrating watthour meters, one of 400 amp., and the other of 600 amp. capacity and four smaller integrating watthour meters for distribution load measurement.

From the board the current is carried by conductors placed in iron conduit to sheet metal distribution and control cabinets located on the various floors.

### Water Service

Water is taken from the city mains and, excepting that for drinking purposes, is pumped by one of two Worthington duplex steam pumps to two 5000-gal. steel tanks located on the roof of the building, and which in turn feed the house system. That for drinking purposes, after being passed through one of two 300-gal.-per-min. International filters, is pumped into a cold water circulating system feeding the drinking water lines of all the guest rooms. The cooling of this water is done by means of a 10 by 3 by 5-ft. water cooler, located in the pump room, and two 5¼ by 3½ by 5-in. Worthington duplex steam-driven pumps are employed to maintain the circulation.

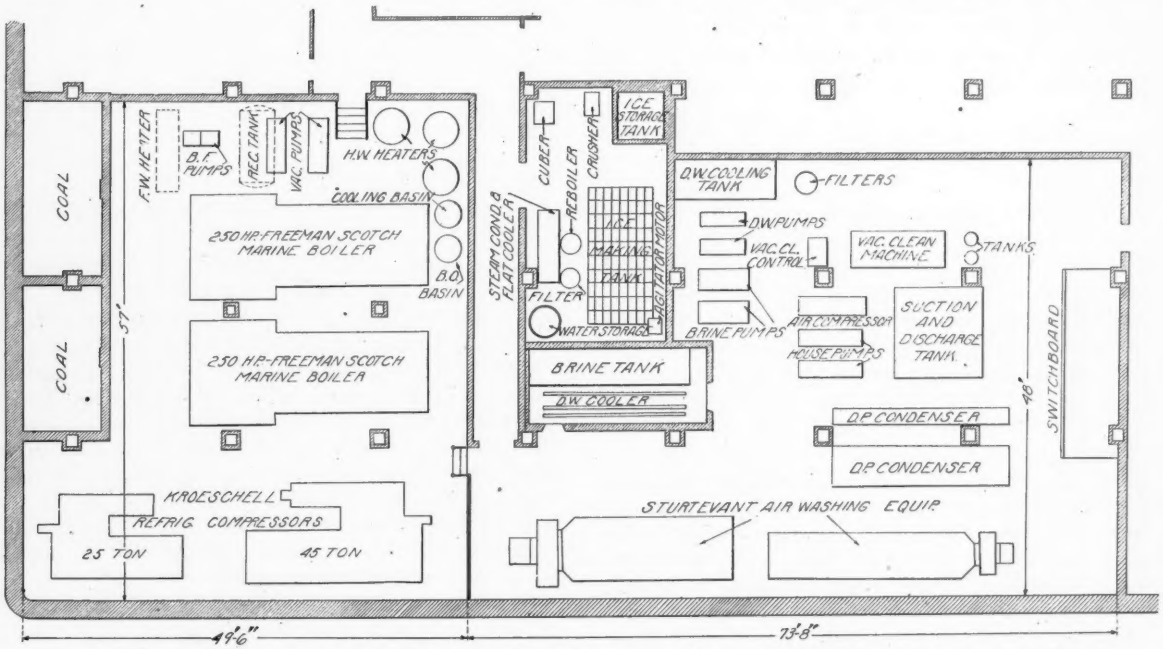


FIG. 5. GENERAL LAYOUT OF HEATING, REFRIGERATING AND AIR WASHING EQUIPMENT OF THE DESHLER

### Refrigerating Machinery

In addition to the cooling of the ice water the refrigerating equipment in this installation is employed for the cooling of the air in the restaurant and the dining rooms, the chilling of the ice boxes and the storage rooms and the manufacture of ice for culinary purposes.

Two Kroeschell carbonic compressors, one of 25 tons and the other of 45 tons capacity, have been installed and are each driven by and direct connected to a Murray Corliss engine of the rolling mill type, the one used in conjunction with the 25-ton machine having a 12 by 24-in. cylinder, while the other has dimensions of 16 by 30 in.

The condenser outfit is of the double-pipe type and is of 75 tons capacity, thereby allowing the simultaneous operation of the two compressors.

There are two double-pipe coolers, the larger of which is made up of three sections each 10 pipes high, and having a length of 20 ft., while the other, used exclusively for the manufacture of ice cream and for general kitchen purposes, is of but a single section, four pipes high and of like length.

The brine circulating system extends to all parts of the house, serving the various kitchens, the bar, the cold storage rooms and the air-cooling apparatus. In all, 24 ice boxes having capacities of from 20 to 800 cu. ft. with a total of 6500 cu. ft., are connected to this system and are maintained at temperatures of from 25 to 42 deg. F., depending upon the goods being cooled. The air-chilling equipment which is primarily used for the cooling of the main restaurant, has a capacity of about 14,000 cu. ft. of air per minute, which may, whenever so desired, be chilled to a temperature of at least 15 deg. F. below that of the outside atmosphere. Approximately 3000 ft. of 4¼-in. extra heavy galvanized iron pipe are used in connection with the chill coils.

Located next to the brine circulating tank is an ice-making tank having dimensions of 19 by 10 by 3 ft., and with a maximum capacity of three tons of ice each 24 hr. This is frozen in 100-lb. cakes but is crushed and cut up into cubes as desired by small motor-driven crushing and cubing machines which have been installed for the purpose.

### Heating and Ventilation

In the guest rooms, halls, corridors and bath and toilet rooms direct heating operated in conjunction with a two-pipe ring system is employed, while in the restau-

rants, dining rooms, ball rooms and assembly rooms and lobby, indirect heating is used, the air for this being furnished by two compressors located in the basement, as shown in Figs. 3 and 5. Each of these compressors is a 6 by 6 by 6-in., steam-driven machine made by the Clayton Air Compressor Works.

Steam for heating and kitchen purposes may be taken direct from the main exhaust lines, from the high-pressure lines through the medium of a reducing valve, or from both of these sources as operating and weather conditions demand. It is first delivered to a 4-in. header carried along the rear of the boiler-room wall from whence it is distributed to the branch lines which feed the various floors and sections of the house through risers provided for the purpose. The main distribution lines are arranged in the form of a ring along the basement ceiling and consist of 3½, 3, 2½ and 2-in. sections.

Condensation is returned by vacuum created by two Blake-Knowles simplex steam pumps which discharge into a 750-gal. receiving tank in the boiler room.

The average ratio of the number of square feet of radiating surface to the total cubical contents of the building is as one to one hundred, while for the rooms on the lower floors, the assembly and dining rooms, the restaurant and the ball room, the ratio is as 1 to 130; for the upper floors, which are occupied almost exclusively by the guest rooms and storage rooms, the ratio is as 1 to 64.

In the pump room are two air conditioners of Sturtevant make, one of which is capable of delivering 20,000 cu. ft. of air per minute, while the other has a rating of approximately 8000 cu. ft. of air per minute. The blowers are operated by direct-connected motors of 13 hp. each, and the water circulating pumps by 7½-hp. machines, also direct connected.

General cleaning of the guest rooms is done by means of a vacuum system, four outlets being provided on each floor for hose connections. A vacuum of about 10 to 12 in. is ordinarily maintained by an Atwood vacuum cleaning machine direct connected to a 12-hp. Sprague electric motor, the speed of which is controlled by a Cutler-Hammer pressure regulator. This equipment, as indicated in Fig. 5, is also in the basement.

# Bearings---I

## Composition of Alloys Employed

IN ORDER to minimize friction and resulting wear, alloys of comparatively soft metals are employed as bearing material instead of wrought iron, cast iron or steel. The principal constituents of such alloys are copper, tin, lead, zinc, antimony, iron and aluminum, and should, when combined, in addition to meeting the above requirements, have strength enough to carry the required load without distortion or undue heating, and when subjected to sudden shocks must not crack or break.

Temperature variation is another important factor demanding consideration, especially in refrigeration plants and the coefficient of expansion of the alloy should be such as to prevent undue binding with consequent destruction of the bearing and possible variation in other properties, such as brittleness and ductility.

Bearing metals may be divided into the four following classes consisting of the bases and minor ingredients indicated:

1. Copper base (50 to 80 per cent) with tin; tin and zinc; tin and lead; or tin, lead and zinc.

2. Tin base (50 per cent or more) with antimony and copper; antimony, copper and lead; or copper and zinc.

3. Lead base (50 per cent or more) with antimony; antimony and tin; or antimony, tin and copper.

4. Zinc base (50 per cent or more) with copper and aluminum.

The alloys of a copper base are harder and stronger than those of the tin, lead or zinc bases, consequently are better adapted to bearings subject to the heaviest pressures. On the other hand, however, due to their inability to conform to irregularities and lack of plasticity, copper-base alloys are liable to heat quite readily under abnormal conditions, due perhaps to the hard unyielding metal causing concentration of the load upon a few high spots and thereby producing an abnormal pressure per unit area.

While adding zinc to copper-tin alloys tends to improve their casting qualities, it also increases their cost considerably so that these alloys are employed only as housings and backs for the softer lining metals.

The standard phosphor-bronze bearing metal which is used for higher grades of work consists of a copper-tin-lead alloy containing a small amount of phosphorus. With the same amount and like conditions of lubrication a bronze containing lead is less liable to heat and the rate of wear is much diminished. In view of this fact and that ordinarily lead is much cheaper than tin, it appears desirable to produce a bearing metal with as much lead and as little tin as possible.

Bearing metals most frequently handled by engineers are of the lead or tin base varieties commonly called babbit metals, the name being derived from that of the inventor of soft-metal-lined bearings, Isaac Babbitt. Tin base metals, according to Mark's Mechanical Engineers' Handbook, are divided into 3 general classes: (1) Those containing tin, antimony and copper; (2) those containing tin, antimony, copper and lead; and (3) those containing tin, copper and zinc. These are said to possess in general a higher resistance to compression than the lead base metals, due to a great extent to the relative percentage of copper and antimony they contained.

The tin-antimony-copper combination which, because of the high tin content, is the most costly of all bearing alloys, is widely employed and is known as genuine babbit, being based upon the original formula of Babbitt, the composition of which is, copper, 3.70 per cent; antimony, 7.40 per cent, and tin, 88.90 per cent.

Another genuine babbit, but somewhat harder than this, has a composition ranging from 83 per cent tin, 8½ per cent antimony, and 8½ per cent copper, to 80 per cent tin, 10 per cent antimony and 10 per cent copper.

Lead added to babbits of the tin base increases the fusibility of the alloy, while, if zinc is added, the metal becomes tough and is somewhat sluggish to pour. Alloys of the tin base containing zinc are extensively employed for marine engine bearings and to some extent for automobile bearings.

Speaking of babbit metals, C. A. Tompkins in the Mechanical News states that lead and antimony have the property of combining with each other in all proportions without impairing the antifriction properties of either. The antimony hardens the lead and when mixed in the proportion of 80 parts lead by weight and 20 parts antimony, no other known composition of metals possesses greater wearing properties, or will stand a higher speed without heat or abrasion. It runs free in its melted state, has no shrinkage, and is better adapted to

TABLE I. COMPOSITION OF ALLOYS USED FOR BEARINGS

| | Copper | Tin | Lead | Zinc | Antimony | Iron |
|---|---|---|---|---|---|---|
| Camelia metal | 70.20 | 4.25 | 14.75 | 10.20 | ..... | 0.55 |
| Anti-friction metal | 1.60 | 98.13 | ..... | ..... | ..... | trace |
| White metal | ..... | ..... | 87.92 | ..... | 12.08 | ..... |
| Car-brass lining | ..... | trace | 84.87 | ..... | 15.10 | ..... |
| Salgee anti-friction | 4.01 | 9.91 | 1.15 | 85.57 | ..... | ..... |
| Graphite bearing-metal | ..... | 14.38 | 67.75 | ..... | 16.75 | ? (1) |
| Antimonial lead | ..... | ..... | 80.69 | ..... | 18.83 | ..... |
| Carbon Bronze | 75.47 | 9.72 | 14.57 | ..... | ..... | .....(2) |
| Cornish bronze | 77.63 | 9.60 | 12.40 | trace | ..... | trace (3) |
| Delta metal | 92.39 | 2.37 | 5.10 | ..... | ..... | 0.07 |
| *Magnolia metal | trace | ..... | 83.55 | trace | 16.45 | trace (4) |
| American anti-friction metal | ..... | ..... | 78.44 | 0.98 | 19.60 | 0.65 |
| Tobin bronze | 59.00 | 2.16 | 0.31 | 38.40 | ..... | 0.11 |
| Graney bronze | 75.80 | 9.20 | 15.06 | ..... | ..... | ..... |
| Damascus bronze | 76.41 | 10.60 | 12.52 | ..... | ..... | ..... |
| Manganese bronze | 90.58 | 9.58 | ..... | ..... | ..... | .....(5) |
| Ajax metal | 81.24 | 10.98 | 7.27 | ..... | ..... | .....(6) |
| Anti-friction metal | ..... | ..... | 88.32 | ..... | 11.98 | ..... |
| Harrington bronze | 55.73 | 0.97 | ..... | 42.67 | ..... | 0.68 |
| Car-box metal | ..... | ..... | 84.33 | trace | 14.38 | 0.61 |
| Hard lead | ..... | ..... | 94.40 | ..... | 5.03 | ..... |
| Phosphor-bronze | 79.17 | 10.22 | 9.61 | ..... | ..... | .....(7) |
| Ex. B. metal | 76.80 | 8.00 | 15.00 | ..... | ..... | .....(8) |

Other constituents:
(1) No graphite.
(2) Possible trace of carbon.
(3) Trace of phosphorus.
(4) Possible trace of bismuth.
(5) No manganese.
(6) Phosphorus or arsenic, 0.37.
(7) Phosphorus, 0.94.
(8) Phosphorus, 0.20.

* Dr. H. C. Torrey says this analysis is erroneous and that Magnolia metal always contains tin.

light high-speed machinery than any other known metal. Care, however, should be taken in using it, and it should never be heated beyond a temperature that will scorch a dry pine stick.

Alloys containing lead, tin and antimony and those containing lead, antimony, tin and copper are also considered as babbits. Addition of copper to the alloy of lead, antimony and tin increases the hardness and causes an increased sluggishness in pouring, depending on the amount of copper present in proportion to the tin. In the high tin carrying alloys, the percentage of copper can be increased, however, without increasing the sluggishness.

With 10 per cent tin, says Marks, not over ½ per cent of copper should be added; with 20 per cent of tin, not over 1 per cent; with 30 per cent of tin, not over 1½ per cent; with 40 per cent of tin, not over 2 per cent, and with 50 per cent of tin, not over 3 per cent of copper. A great many babbit metals are on the market having these four constituent metals in their composition, which are known as copper-hardened babbit, and are designated by grades according to the amount of tin they contain.

The most generally used zinc base bearing metal consists of 85 per cent zinc, 10 per cent copper, and 5 per cent aluminum, and is known as Lumen Metal. This alloy is readily machined and is well adapted for use in motor bearings, crane bearings and in fact in all high-speed service where the weight to be carried by the bearings is comparatively light.

### Substitute for Babbit Metal

On account of the present scarcity of copper in Germany, says Machinery, determined efforts have been made to substitute alloys containing little or no copper for those containing high percentages. It is stated in Glasers Annalen that German metallurgists have succeeded in producing a bearing metal alloy containing an exceedingly small percentage of copper, and a fairly small percentage of tin, which has all the properties of the highest grade of bearing metal. The alloy consists of 3.3 per cent copper, 12 per cent lead, 21.3 per cent tin and 63.4 per cent zinc. The alloy is produced by melting red brass and adding to it first the tin and lead, and finally the required amount of zinc, which before being added to the molten alloy is preheated to about 400 deg. F.

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An investigation has been completed by the Engineering Experiment Station, University of Illinois, under the direction of Fred B. Seeley, Associate in Theoretical and Applied Mechanics, to determine the effects of mouthpieces upon the flow of water through a submerged short pipe. A knowledge of the extent of the loss of head due to contraction or expansion of a stream is of considerable importance in a variety of hydraulic problems. For example, it may be possible, through attention to the shape and angle of connections and intakes to increase the flow through the suction and discharge pipes of low head pumps, through large valves, through locomotive water columns, through the sluiceways of dams, through culverts and short tunnels, etc.

It is to be noted that losses of head due to contraction or expansion of a stream, which may in themselves be of relatively little consequence, may have a considerable influence upon subsequent losses because of the turbulent motion started by the contraction or expansion. A slight change in the conditions under which flow takes place may cause a large difference in the action or behavior of the water.

The experiments conducted by Mr. Seely involved the use of a cast-iron pipe 22½ in. long and 6 in. in diameter, bored to a smooth surface. Cast-iron conical mouthpieces of different lengths and angles were used. The laboratory tank employed was divided into two compartments by a vertical partition in which the short pipe was set in a horizontal position.

The results of the investigation are set forth in detail in Bulletin 96 of the Engineering Experiment Station, copies of which may be obtained gratis by addressing C. R. Richards, Director, Urbana, Ill.

# Power Plant Instruments as an Investment---II

INSTRUMENTS FOR MEASURING TEMPERATURE; TYPES EMPLOYED; MOST IMPORTANT USES. BY M. A. SALLER

PROBABLY the most important general consideration in power plant practice is the matter of temperature, and hence a complete and accurate equipment of thermometers is of paramount importance. In order to be properly acquainted with the action of the various pieces of apparatus in operation in the power plant, it is necessary to have a check upon the temperature of the steam, water, air and gases because variations or changes in temperature will indicate that important changes have taken place, and for this reason the question of having complete control of the various temperatures throughout the plant is of utmost value.

In the power plant, the thermometer, whether it be in the form of the ordinary mercurial tube, recording thermometer, or pyrometer, is the means for measuring the temperature of various liquids or gases which form

TABLE I. PER CENT SAVING FOR EACH DEGREE OF INCREASE IN TEMPERATURE OF FEED WATER HEATED BY WASTE STEAM

| Initial Temp. of Feed | Pressure of Steam in Boiler, lbs. per sq. in. above Atmosphere | | | | | | | | | | | Initial Temp. of Feed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | |
| 32° | .0872 | .0861 | .0855 | .0851 | .0847 | .0844 | .0841 | .0839 | .0837 | .0835 | .0833 | 32° |
| 40 | .0878 | .0867 | .0861 | .0856 | .0853 | .0850 | .0847 | .0845 | .0843 | .0841 | .0839 | 40 |
| 50 | .0886 | 0875 | 0868 | .0864 | .0860 | .0857 | .0854 | .0852 | .0850 | .0848 | .0846 | 50 |
| 60 | .0894 | .0883 | .0876 | .0872 | .0867 | .0864 | .0862 | .0859 | .0856 | .0855 | .0853 | 60 |
| 70 | .0902 | .0890 | 0884 | .0879 | .0875 | 0872 | .0869 | .0867 | .0864 | .0862 | .0860 | 70 |
| 80 | .0910 | .0898 | .0891 | .0887 | .0883 | .0879 | .0877 | .0874 | .0872 | .0870 | .0868 | 80 |
| 90 | .0919 | .0907 | .0900 | .0895 | .0888 | .0887 | .0884 | .0883 | .0879 | .0877 | .0875 | 90 |
| 100 | .0927 | .0915 | .0908 | .0903 | .0899 | .0895 | .0892 | .0890 | .0887 | .0885 | .0883 | 100 |
| 110 | .0936 | .0923 | .0916 | .0911 | .0907 | .0903 | .0900 | .0898 | .0895 | .0893 | .0891 | 110 |
| 120 | .0945 | .0932 | .0925 | .0919 | .0915 | .0911 | .0908 | .0906 | .0903 | .0901 | .0899 | 120 |
| 130 | .0954 | .0941 | .0934 | .0928 | .0924 | .0920 | .0917 | .0914 | .0912 | .0909 | .0907 | 130 |
| 140 | .0963 | .0950 | .0943 | .0937 | .0932 | .0929 | .0925 | .0923 | .0920 | .0918 | .0916 | 140 |
| 150 | .0973 | .0959 | .0951 | .0946 | .0941 | .0937 | .0934 | .0931 | .0929 | .0926 | .0924 | 150 |
| 160 | .0982 | .0968 | .0961 | .0955 | .0950 | .0946 | .0943 | .0940 | .0937 | .0935 | .0933 | 160 |
| 170 | .0992 | .0978 | .0970 | .0964 | .0959 | .0955 | .0952 | .0949 | .0946 | .0944 | .0941 | 170 |
| 180 | .1002 | .0988 | .0981 | .0973 | .0969 | .0965 | .0961 | .0958 | .0955 | .0953 | .0951 | 180 |
| 190 | .1012 | .0998 | .0989 | .0983 | .0978 | .0974 | .0971 | .0968 | .0964 | .0962 | .0960 | 190 |
| 200 | .1022 | .1008 | .0999 | .0993 | .0988 | .0984 | .0980 | .0977 | .0974 | .0972 | .0969 | 200 |
| 210 | .1033 | .1018 | .1009 | .1003 | .0998 | .0994 | .0990 | .0987 | .0984 | .0981 | .0979 | 210 |
| 220 | . . . | .1029 | .1019 | .1013 | .1008 | .1004 | .1000 | .0997 | .0994 | .0991 | .0989 | 220 |
| 230 | . . | .1039 | .1031 | .1024 | .1018 | .1012 | .1010 | .1007 | .1003 | .1001 | .0999 | 230 |
| 240 | . . . . | .1050 | .1041 | .1034 | .1029 | .1024 | .1020 | .1017 | .1014 | .1011 | .1009 | 240 |
| 250 | . . . . | .1062 | .1052 | .1045 | .1040 | .1035 | .1031 | .1027 | .1025 | .1022 | .1019 | 250 |

the basis of the operation and efficiency of the plant, and it would prove to be as unsatisfactory as a dry goods merchant attempting to do business without a yard-stick for a power plant operator to attempt its operation without adequate means for measuring temperature; i.e., a full complement of thermometers.

Since the thermometer is therefore a necessity in power plant operation it is not so much a question of whether thermometers should be installed, but rather a question of how many should be installed. The cost for this class of instrument is so low at the present time that it can be safely said that it pays to have a thermometer installed wherever any liquid or gas is present in such a form that it would make it desirable to know its temperature.

Suitable thermometer equipment should be installed in the feed water lines, cold water supplies, inlet and outlet water to condensers, economizers, or other heat interchangers, on return lines, superheaters, etc. Temperature readings of flue gases, cooling air for turbo-generators, etc., should also be provided for.

The great variety of uses for thermometers in power plant work and the wide range of temperatures encountered makes it especially desirable that attention be given to the selection of an instrument best suited for the work—i.e., an instrument of the proper type, and also an instrument having a range of operation best suited for the work in hand, it being borne in mind that the smaller the range of temperature to be covered the greater the accuracy of results. For general power plant work, thermometers may be divided into the following temperature ranges:

| Class of work— | Temp. range to be provided |
|---|---|
| Feed water | 30 deg. to 240 deg. F. |
| Condenser water | 30 deg. to 160 deg. F. |
| Economizer | 50 deg. to 400 deg. F. |
| Superheater | 200 deg. to 800 deg. F. |
| Flue gas | 210 deg. to 1000 deg. F. |
| Air ducts | 0 deg. to 160 deg. F. |
| Steam lines | 200 deg. to 400 deg. F. |
| General testing | —30 deg. to 120 deg. F. |
| | 30 deg. to 220 deg. F. |
| Furnace work | 1000 deg. to 2400 deg. F. |
| | 1800 deg. to 3600 deg. F. |

For general power plant work thermometers are usually of the following types:

Ordinary glass tube mercurial expansion type, used in connection with practically all ranges of temperature up to 400 deg. F. This type of instrument is very accurate, fairly cheap, and can be very readily adapted for different ranges of pressure. The operation of the mercurial tube thermometer is also extremely simple, has no moving parts to become deranged, permits of convenient installation under almost any kind of location or position, and in general is a very satisfactory instrument for the purposes required.

Expansion bellows containing gas or volatile liquids. The development of the recording type of thermometer during the past few years has brought into prominence the use of other expansive elements than mercury for the purpose of operating the thermometer, and therefore in the average recording thermometer a bellows or diaphragm containing some volatile gas or liquid is used to register the changes in temperature and to supply motion to the pen which traces the record of the chart. While this type of thermometer is sufficiently accurate for average power plant work, especially if frequently calibrated, there is still the opportunity for inaccuracies setting in because of the collection of dust or grit on the moving parts, rusting, etc. The peculiar advantages of the recording thermometer will be taken up later. The bellows type instrument is also suited for the average ranges of temperature as mentioned above for the glass tube thermometer, though this type can also be adapted for somewhat higher ranges, say up to 800 or 1000 deg.

Pyrometers are specially adapted for taking measurements of extremely high temperatures that are past

the range of the glass tube or bellows type. Pyrometers can be used to advantage on all temperatures above say 500 deg. F. Pyrometers are made along a number of different lines; thermo-electric pyrometers depending for their action on the fact that when two wires of different metals are joined at both ends so as to form a complete metallic circuit, and heat is applied at one junction, the other junction being kept at a lower temperature, an electromotive force proportional to the difference in temperature is set up, which can be measured with a galvanometer. In the commercial instrument the two wires which form the thermo-couple are connected to the galvanometer which is arranged to indicate the temperature in degrees F. or C. Radiation pyrometers depend upon the measurements of heat radiated from the hot body, the rays being reflected by a concave mirror or lenses upon a thermo-couple at the focus. This type is especially suited for very high temperatures since the apparatus itself does not come in contact with the temperature to be measured.

Expansion pyrometers depend on the different rates of expansion of two metals. Usually two rods, one of steel or brass and one of graphite are set alongside of each other, the difference in expansion being transmitted by means of a set of levers and gears to a dial which indicates the temperature on a scale which has been duly calibrated. For average power house work this type has a number of advantages. It is rugged, not complicated, will measure accurately up to 2000 deg. F., and is quite inexpensive as compared with some of the other electrical pyrometers.

For lower temperatures, i. e., up to 1000 deg. F., the mercurial type of pyrometer is frequently used. This instrument is designed along the same lines as the ordinary glass tube thermometer, with the exception that it is made of a special high temperature glass, and then the space above the mercury is filled with nitrogen to keep the mercury from boiling at the high temperatures.

## Recording Thermometers

When making the selection of a thermometer, consideration should be given to the desirability of using a recording thermometer in place of the ordinary index or indicating scale thermometer. The recording thermometer has the tremendous advantage over the plain index thermometer of giving a continuous and graphic record of the temperature maintained, covering the entire day or night, thus eliminating the time and trouble of making frequent readings and notations from the indicating instrument to a log sheet, and thereby enabling the operator to check up the condition of operation for the entire day, or even a longer period, to detect and remedy variations that otherwise would probably have been unnoticed. The record from the recording thermometer is also in such form that it can be filed away with the other plant records for reference at any future time.

Another advantage of the recording thermometer is that a more convenient installation can usually be made, i. e., the expansion bulb can be located where necessary while the recording apparatus can be installed at some convenient point where it is accessible and where there is plenty of light for reading and adjustment, as, for instance, on the central gage board with all the other pressure gages and instruments.

## Installation

After securing a thermometer suited for the conditions, the next step is to see that it is properly installed and cared for. The vital point of the thermometer is the expansion bulb chamber which comes in contact with the liquid or gas to be measured, and it is highly important that this bulb be brought in full direct contact with the flow of the liquid or gas so that a fair reading is obtained. Care should be exercised to see that it is not dead-ended or pocketed in some motionless body of the liquid or gas. For this reason the bulb should be installed preferably in a horizontal run of pipe so drilled and tapped that the bulb is fully immersed in the flow.

The bulb and well containing it should also be inspected frequently to see that the accuracy of the readings is not impaired because of an accumulation of scale, mud or oil.

TABLE II. EFFECT OF THE TEMPERATURE OF COOLING WATER AND DISCHARGE WATER ON VACUUM OBTAINABLE IN SURFACE CONDENSER

| Temp. of Cooling Water, Deg. F. | Temp. of Discharge Water, Deg. F. | Vacuum, Inches Mercury | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 22 | 24 | 26 | 27 | 28 | 29 | 29.5 |
| 35 | 80 | 22.3 | 22.5 | 22.6 | 22.8 | 22.9 | 23.2 | 23.5 |
| | 90 | 18.3 | 18.3 | 18.4 | 18.5 | 18.8 | 19.0 | 19.2 |
| | 100 | 15.4 | 15.5 | 15.6 | 15.8 | 15.9 | 16.1 | 16.2 |
| | 110 | 13.5 | 13.6 | 13.6 | 13.6 | 13.7 | 13.9 | 14.1 |
| | 120 | 11.8 | 11.9 | 12.0 | 12.0 | 12.1 | 12.3 | 12.4 |
| | 130 | 10.6 | 10.6 | 10.7 | 10.8 | 10.8 | 11.0 | 11.1 |
| | 140 | 9.5 | 9.6 | 9.7 | 9.8 | 9.8 | 9.9 | 10.0 |
| 40 | 80 | 25.1 | 25.3 | 25.5 | 25.6 | 25.8 | 26.1 | 26.4 |
| | 90 | 20.1 | 20.2 | 20.4 | 20.5 | 20.6 | 20.9 | 21.1 |
| | 100 | 16.7 | 16.8 | 17.0 | 17.1 | 17.2 | 17.4 | 17.6 |
| | 110 | 14.3 | 14.4 | 14.5 | 14.6 | 14.7 | 14.9 | 15.1 |
| | 120 | 12.5 | 12.6 | 12.7 | 12.8 | 12.9 | 13.0 | 13.2 |
| | 130 | 11.1 | 11.2 | 11.3 | 11.4 | 11.4 | 11.6 | 11.7 |
| | 140 | 10.0 | 10.1 | 10.2 | 10.3 | 10.4 | 10.4 | 10.5 |
| 50 | 80 | 33.5 | 33.7 | 34.0 | 34.2 | 34.4 | 34.9 | 35.2 |
| | 90 | 25.1 | 25.3 | 25.5 | 25.6 | 25.8 | 26.1 | 26.4 |
| | 100 | 20.1 | 20.2 | 20.4 | 20.5 | 20.6 | 20.9 | 21.1 |
| | 110 | 16.7 | 16.8 | 17.0 | 17.1 | 17.2 | 17.4 | 17.6 |
| | 120 | 14.3 | 14.4 | 14.5 | 14.6 | 14.7 | 14.9 | 15.1 |
| | 130 | 12.5 | 12.6 | 12.7 | 12.8 | 12.9 | 13.0 | 13.2 |
| | 140 | 11.1 | 11.2 | 11.3 | 11.4 | 11.4 | 11.6 | 11.7 |
| 60 | 80 | 50.3 | 50.6 | 51.0 | 51.3 | 51.7 | 52.3 | 52.9 |
| | 90 | 33.5 | 33.7 | 34.0 | 34.2 | 34.4 | 34.9 | 35.2 |
| | 100 | 25.1 | 25.3 | 25.5 | 25.6 | 25.8 | 26.1 | 26.4 |
| | 110 | 20.1 | 20.2 | 20.4 | 20.5 | 20.6 | 20.9 | 21.1 |
| | 120 | 16.7 | 16.8 | 17.0 | 17.1 | 17.2 | 17.4 | 17.6 |
| | 130 | 14.3 | 14.4 | 14.5 | 14.6 | 14.7 | 14.9 | 15.1 |
| | 140 | 12.5 | 12.6 | 12.7 | 12.8 | 12.9 | 13.0 | 13.2 |
| 70 | 80 | 100.6 | 101.2 | 102.1 | 102.7 | 103.4 | 104.7 | 105.8 |
| | 90 | 50.3 | 50.6 | 51.0 | 51.3 | 51.7 | 52.3 | 52.9 |
| | 100 | 33.5 | 33.7 | 34.0 | 34.2 | 34.4 | 34.9 | 35.2 |
| | 110 | 25.1 | 25.3 | 25.5 | 25.6 | 25.8 | 26.1 | 26.4 |
| | 120 | 20.1 | 20.2 | 20.4 | 20.5 | 20.6 | 20.9 | 21.1 |
| | 130 | 16.7 | 16.8 | 17.0 | 17.1 | 17.2 | 17.4 | 17.6 |
| | 140 | 14.3 | 14.4 | 14.5 | 14.6 | 14.7 | 14.9 | 15.1 |
| 80 | 90 | 100.6 | 101.2 | 102.1 | 102.7 | 103.4 | 104.7 | 105.8 |
| | 100 | 50.3 | 50.6 | 51.0 | 51.3 | 51.7 | 52.3 | 52.9 |
| | 110 | 33.5 | 33.7 | 34.0 | 34.2 | 34.4 | 34.9 | 35.2 |
| | 120 | 25.1 | 25.3 | 25.5 | 25.6 | 25.8 | 26.1 | 26.4 |
| | 130 | 20.1 | 20.2 | 20.4 | 20.5 | 20.6 | 20.9 | 21.1 |
| | 140 | 16.7 | 16.8 | 17.0 | 17.1 | 17.2 | 17.4 | 17.6 |
| 90 | 100 | 100.6 | 101.2 | 102.1 | 102.7 | 103.4 | 104.7 | 105.8 |
| | 110 | 50.3 | 50.6 | 51.0 | 51.3 | 51.7 | 52.3 | 52.9 |
| | 120 | 33.5 | 33.7 | 34.0 | 34.2 | 34.4 | 34.9 | 35.2 |
| | 130 | 25.1 | 25.3 | 25.5 | 25.6 | 25.8 | 26.1 | 26.4 |
| | 140 | 20.1 | 20.2 | 20.4 | 20.5 | 20.6 | 20.9 | 21.1 |

Special right angle sockets and connections can be secured for inserting thermometers in the side of tanks, etc. It is obvious that the thermometer should also be placed in a vertical position.

For power plant work it is advisable to have the case supporting the thermometer scale made of substantial iron or brass castings in order to insure a good protection against injury. A tin case thermometer, while cheaper, is not nearly so serviceable or accurate.

Where considerable vibration is present, the thermometer should be protected and isolated by means of thick rubber washers or gaskets, since constant vibration will seriously affect the accuracy, especially in instruments of the recording type.

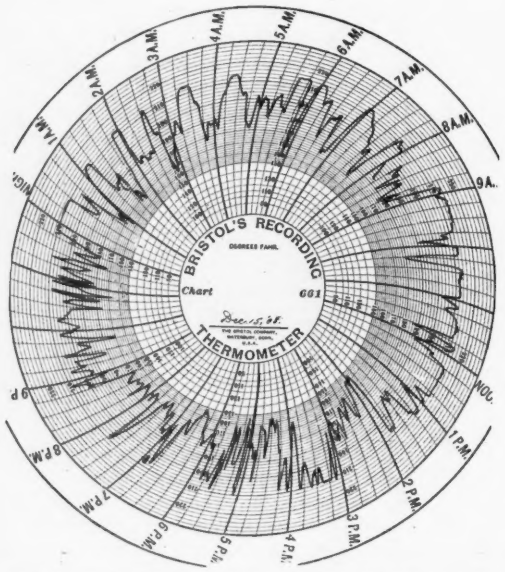
Where the thermometer is installed in a dark place it is usually worth the expense to install an electric bulb so that the scale is properly illuminated. An error in

making readings under unfavorable conditions might more than offset the cost of providing adequate light. In dark and gloomy places, white dials with large black figures should be used.

For taking readings in difficult locations where the dial cannot readily be observed, a maximum self-registering type of thermometer is made by forming a contraction in the base of the mercury tube just above the bulb, so arranged that it permits the rise of the mercury up to a maximum point as caused by the temperature encountered; however, when the thermometer is removed from the source of the heat, this contraction in the tube does not permit the mercury to flow back, but holds it at the maximum point reached so that this temperature can be noted. The mercury can then be driven back by holding the thermometer at the top and throwing it outward with a jerky motion.

## Calibration

The accuracy of all thermometers should be checked at intervals and therefore where a large number of ther-




SAMPLE CHART OF RECORDING THERMOMETER SHOWING FLUCTUATIONS WITH INDEX TYPE

mometers are in use it pays to have on hand a calibrating set whereby the freezing point, boiling point and different steam temperature points can be checked. Where the number of thermometers in use does not seem to warrant the expenditure of money the instruments can be sent to the manufacturers for calibrating.

The freezing point can readily be obtained by packing around the bulb of the thermometer a quantity of broken ice, the ice being packed in such a manner that while the tube is entirely surrounded by melting ice, it is not submerged in the resulting cold water. After remaining in the ice pack 5 or 8 min., the location of the mercury column will indicate the freezing or melting point.

For ascertaining the boiler point the thermometer bulb is placed directly above a vessel containing boiling water, in such a manner that it registers the temperature of the steam being liberated.

An easy method of testing the accuracy of a thermometer above 212 deg. is suggested by the fact that the temperature of saturated steam varies with its absolute pressure, as indicated on the steam tables. Hence by subjecting the bulb to saturated steam at a known pressure, and then noting the temperature it registers to see whether it corresponds with the known temperature corresponding to the pressure, a curve can be plotted which will give a correction factor, if any, which should be used.

## Opportunities for Saving as Pointed Out by the Installation of Thermometer

The thermometer is regarded as so essential to proper and economical power plant operation, and the first cost of the instrument is so comparatively low that little special effort has been made to figure out the money value of investment. Nevertheless the investment in a full complement of thermometers is very desirable because of the check which the measurement of temperature affords on general plant conditions.

The thermometer offers the greatest possibilities when installed in connection with boiler feed water service. The savings and benefits derived from feeding hot water to boilers are quite apparent and in the vast majority of plants some effort is made to heat the feed water before it enters the boilers, though in a great many of these plants the maximum saving is not realized because thermometers are not installed in the feed lines to show up variations and fallings off in temperature.

It has been shown by theory and proven up by practice that for each 10 deg. rise in the temperature of the feed water a saving of one per cent on fuel consumed under the boilers is realized. For that reason it is of considerable importance to have a check on the feed water temperature to see that it is being maintained at the maximum point.

Take a very small plant, say 150 hp., where the coal bill for the year will average say $6000 or $8000. If the installation of a thermometer insures a feed water temperature of 210 deg. by making use of all waste exhaust steam, whereas prior to the checking of the temperature an average of say only 180 deg. was obtained, the increase of 30 deg. means a fuel saving of three per cent, i. e., $180 to $240 per year, many times the cost of the thermometer equipment.

A thermometer on the feed line will detect the falling off in temperature when the feed-water heater becomes fouled, or when the heater is allowed to overflow and waste water and steam, or when the heater is air-bound, or in any way failing to perform its full duty.

Where exhaust steam is limited and use can be made of it in other service than heating the feed water, such as in drying coils, etc., it often pays to install a thermometer on the cold water inlet line so that the amount of steam used in the heater to heat the feed water can be calculated from time to time.

Where economizers are installed, thermometers are also useful in checking the work done by the economizer, and also for showing up any falling off in efficiency as a result of dirty tubes, due to soot or scale.

Where a heating system is in service, it is also desirable in some cases to place a thermometer on the returns and the temperature checked against the temperature of the steam put in will serve to show the amount

of heat required in the system, and can be used as a basis for charging the cost of steam to the heating account.

If the thermometer on the return line shows a temperature of 110 or 120 deg. an effort will naturally be made to conserve and save the hot water by diverting it to the feed-water heater, whereas ordinarily this hot water might be carried to waste.

Next to the thermometer in the feed line, probably the most important location is in the flue of the boilers since the temperature of the outgoing gases will to a marked degree afford a gage on the degree of heat efficiency attained in the boiler.

Let us suppose that under normally good conditions at full load the temperature of the flue gases is 500 to 520 deg. If the thermometer in the flue indicates a temperature of 600 or 700 deg. it can be taken for granted that something requires attention. It may be that the boiler tubes are dirty either with soot or scale, and hence cannot absorb the heat from the gases of combustion, which heat is thereby being rejected to the stack. Or broken baffling in the combustion chamber may be allowing these hot gases to short-circuit to the stack. Or again a big drop in the temperature of the flue gases will indicate an excess supply of air due to air leaks in the setting, or improper firing conditions.

The efficiency of a boiler decreases with the increase in temperature of the waste flue gases, and as this flue temperature therefore offers a direct check on the efficiency of the installation, the insertion of a thermometer is of vital importance. The efficiency of heat absorption by a boiler can be stated as equaling $\frac{T_1 - T_2}{T_1 - T_3}$

$T_1$ = temp. of gases just before reaching heating surface
$T_2$ = temp. of gases just after leaving heating surface
$T_3$ = temp. of outside air.

The heat lost in flue gases amounts to as much as 25 or 30 per cent of the heat supplied by the fuel, though by careful management this can be reduced to 10, 12 or 15 per cent. To effect this very substantial saving, the use of proper thermometer equipment is absolutely necessary.

In a surface condensing plant, the thermometer is of great aid in maintaining proper condenser efficiency. The efficiency of turbines or engines running condensing is dependent on the amount of vacuum carried in the condenser (every inch of vacuum above 24 or 25 in. of mercury means that the steam consumption of a turbine is reduced from 4 to 6 per cent and the degree of vacuum secured is dependent on the temperature of the cooling or circulating water, so that the information given by the thermometer in condenser work has a very direct bearing on the successful and economical operation of the unit.

The desideratum in condenser practice is to secure the condensation of the steam with the minimum temperature difference between the condensed steam and water at outlets, and the installation of thermometers in the cooling water and condensate lines will show to what extent the condenser is doing this work, and will show whether the condenser needs cleaning, is air bound, etc. If the check afforded by the thermometer will enable the vacuum to be maintained at 26 instead of 25 in., the saving in steam consumption of from 4 to 6 per cent that would follow would certainly prove an excellent return on the investment.

In connection with water cooling systems, the thermometer is an absolute necessity for checking the operation of the equipment, and to provide for changes according to fluctuations in load and weather conditions.

In power plants, especially those where a full complement of thermometers is not installed, it is advisable to have on hand several thermometers of various ranges for use in making tests, for checking the temperatures of certain lines, etc. Where it is not deemed necessary to have a thermometer permanently installed, provision should be made for frequently checking the temperature of the line by using one of the test thermometers, inserted in a permanent pocket or well set in the line at the desired points.

From the foregoing it will be noted that the three most important possibilities for savings due to thermometers are in connection with the feed water, flue gases and condenser work; and the savings or losses possible are so momentous that it pays to install in these locations a thermometer of the recording type so that a continuous graphic record of the range and variations in temperature is secured. While the index thermometer will give accurately the temperature at the time the reading is observed, no record is obtained of the temperature action during the major portion of the time when no notation is being made. The recording thermometer turns out a chart showing all the fluctuations in such a manner that the operation can be studied in connection with the operation of all the other equipment, and any improper operating conditions remedied.

Take for example the chart of a recording feed-water thermometer as reproduced here. The sharp fluctuations which take place at frequent intervals would in all probability not have been noticed on an index thermometer. Nevertheless the record chart shows them up very forcibly and indicated that something was wrong with the feed-water heating equipment. Either the supply of exhaust was not sufficient at all times, or else the feeding was done spasmodically, or the feed-water heater was overloaded, or the heater needed cleaning. At any rate the feed water temperature record as produced on the chart should open the way for bringing up to 210 or 212 deg. a feed-water temperature that did not average more than 190 or 195 deg., hence leading to a possible saving in the fuel bill of 1 to 2 per cent—certainly amounting to a sum that would more than pay for the extra cost of the recording thermometer as compared with the cheaper index instrument.

In connection with flue gases, also, would this recording feature be of value because of the rapid fluctuations in temperature that take place due to rapidly changing furnace conditions brought about by firing, change of draft, etc.

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THE ABILITY to perform a piece of work a little better than the other fellow creates a demand for this service that places a premium on the worker and his work. This skill is never acquired in merely wishing for it; the wish must be resolved into action. A few hours each week devoted to conscientious study coupled with intelligent application to one's work will produce gratifying results. Prepare yourself to fill a good position.

# Bagasse Burning

By A. Guell

IN A paper before the Louisiana Sugar Planters Association, Bulletin No. 160, by Prof. E. W. Kerr from the state Agricultural Experiment Station was reviewed, giving the conclusions from tests of boilers burning bagasse, the refuse from sugar cane mills.

Because of the great amount of moisture, 40 to 65 per cent, a large combustion chamber is needed, otherwise the great volume of gases and superheated steam will pass through at such a high velocity that combustion will be incomplete. The greater the per cent of moisture, the larger the chamber needed.

Draft is best regulated by dampers in the breechings for there is less tendency for inleakage of air through the setting above the fire than when ashpit doors are used for draft regulation; also the grates are kept cooler, because a larger volume of air passes through them at all times. The large combustion chamber presents large surface for inleak of air, and for radiation, hence damper control of draft is particularly desirable in these furnaces. The great mass of fire brick in a large chamber acts as a heat flywheel, since when heated it tends to maintain a high temperature, and the Dutch oven setting is particularly good in this respect.

In the furnace proper, the rate of combustion varies from 50 to 300 lb. of bagasse per square foot of grate per hour, giving an output of 3.5 to 20 boiler horsepower per square foot of grate. If the moisture is high, a high rate of combustion gives best results. With a large grate, open setting and possibility of great air leaks, high draft tends to poor efficiency, and with such conditions, forced draft with pressure in the ashpit is more efficient than stack draft giving vacuum since the air inleakage is less.

With a small grate, close setting and hopper fitted to exclude air, high draft is required and proved efficient.

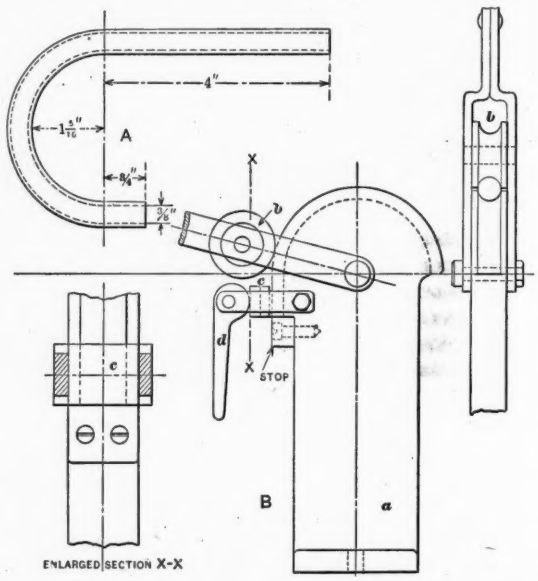
To control draft properly, gages are needed, and the firemen can soon learn to understand their use. Draft in the firebox varies with the draft in the breeching, and increases with thick fire and a bed of clinker. A low draft reading with the damper open indicates holes in the fire and a high draft indicates a dirty fire.

Best economy is secured with high furnace temperature, a high rate of combustion and high $CO_2$ in flue gases, but effort to secure too high a per cent of $CO_2$ may result in low air supply and too much CO. About 12 to 13 per cent $CO_2$ was found to give best efficiency. Excessive overload reduces efficiency; in one case reducing the draft with a high stack by one-half was found to give 26 per cent increase in evaporation. But at moderate overloads the economy was found to be as good as or better than that at rated load or underload. Fifty-five and seven-tenths per cent overload gave 4.12 lb. equivalent evaporation per 1 lb. of dry bagasse; 26 per cent overload gave 4.52 lb. and 23.6 per cent, 5.23 lb.

Power produced was 0.89 to 1.12 hp. per 1 ton bagasse burned in 24 hr., the average result being 1.02 hp. per ton. In other tests, 1.16 hp. per ton was secured with 9.8 per cent fiber in the bagasse and low efficiency; and 1.44 hp. per ton with 11 per cent fiber and high efficiency.

# Tube Bender

BENDING of tubes is always a more or less difficult matter, and the difficulty increases with the thinness of the walls of the tube and the shortness of the radius of the bend. Heavy gage tubes are comparatively easy to bend to a large radius without an excessive amount of flattening; but with a short-radius, thin-walled tube, it is a tedious piece of work to make a good-looking bend. The writer designed the tube bender shown in the accompanying illustration for a ⅜-in. tube about 0.010 in. thick, of the shape shown at *A*. The fixture illustrated at *B* consists of a cast-iron body, *a*, grooved to the proper radius for the bend




TUBE BENDER ADAPTED FOR HANDLING THIN TUBING

required, of suitable dimensions to allow the tube to pass freely through the groove, and terminating in a straight portion. The runner, *b*, is of machine steel grooved to comply with the form of the groove of body *a*. The gripping jaw, *c*, is also grooved, and in practice is clamped to the end of the tube by means of the eccentric, *d*. The device can be fastened to the work-bench or clamped in the vise. The operation is simple and efficient, and has never failed to work.—Ernest Schwartz, in Machinery.

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You will find that in all lines of important business the big men are those who began as poor boys and without influence rose to their present positions. It is just as true of the boy who, starting today, is eligible as their successor. "Pull" has not the slightest effect. Nor has the young man who gets to the office only when he must and keeps his eye on the clock, when the hour for leaving draws near, a chance. The young man who goes into a business so interested in it that he will forget there is a clock and so enthusiastic about it that he will work whenever it is necessary, need not worry about the future. No business is so big that such a man is lost in it.—A. C. Bedford.

# Electrical Machinery and Appliances

*For Generating, Transmitting and Using Current*

## Single-Phase Motors---II

CHARACTERISTICS OF THE REPULSION AND UNITY POWER FACTOR MOTORS. BY GORDON FOX

THE so-called repulsion motor is shown diagrammatically in Fig. 6. In this the field winding is connected directly across the line, while the armature is short-circuited by brushes set at an angle to the axis of the field. A magnetizing current flows in coil S, setting up a vertical flux which we will call transformer flux T. This pulsating flux induces voltage in the motor conductors. Since the rotor is short-circuited by the brushes, a current flowing through the conductors in the sectors 360—4a deg., tends to set up a vertical flux, R. The same current, flowing through conductors in sectors 4a, sets up a horizontal flux, Fr. The vertical flux, R, causes load current to flow in coil S, neutralizing R, an action similar to load transfer between the windings of a transformer. Since R and Fr are set up by the same up the load current in the rotor. This tendency to lessen the rotor current makes necessary increased inducing flux T to maintain the load current. The above counter voltage is proportional to the speed. The transformer flux, T, thus increases with the speed.

Briefly stated, the repulsion motor is, in action, a transformer, the secondary being movable and the secondary coil being short-circuited on a line inclined at an angle with the primary coil. The secondary current, flowing in portions of the rotor conductors, sets up the main field and the same current, flowing in the balance of the rotor conductors, reacts upon that field to produce torque. If the brushes were placed in line with the field winding, there would be no field Fr, the flux all being vertical. Current would be induced

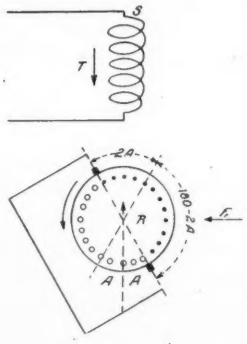


FIG. 6. DIAGRAM OF CONNECTIONS OF SIMPLE REPULSION MOTOR

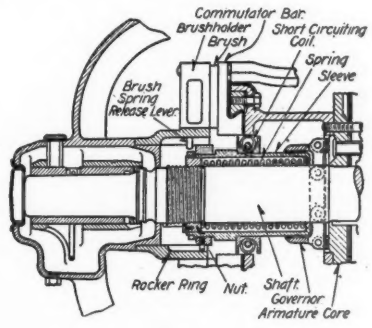


FIG. 7. SECTION OF CENTRIFUGAL SWITCH —REPULSION START INDUCTION MOTOR

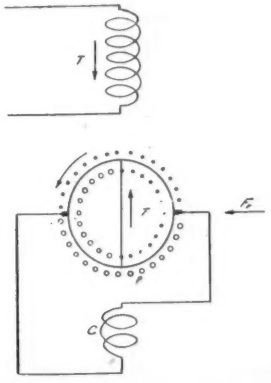


FIG. 8. DIAGRAM OF CONNECTIONS OF REPULSION INDUCTION MOTOR

induced current, they are in phase with each other. The induced current is in phase with Fr. The current flowing in conductors 360—4a reacts upon Fr to produce torque. The vertical transformer flux, T, reacts upon the current in conductors 4a to produce auxiliary positive or assisting torque, which is small because of phase difference between the current and the flux.

Rotor conductors 4a, cutting transformer flux T, have generated in them a voltage in phase with this flux. This voltage is 90 deg. in advance of the induced voltage and the resulting current tends to improve the power factor. This influence is greater the higher the speed.

Rotor conductors 360—4a, cutting the flux, Fr, have generated in them a voltage in phase with Fr, which voltage opposes partially the induced voltage which sets in the armature conductors, but no torque would result, since this current would be in quadrature with the only existing flux, the vertical flux. If the brushes were located 90 deg. from this position, no current would be induced in the secondary, since the voltages induced in the various conductors would neutralize each other. The first position mentioned above is commonly called the live neutral; the second position, the dead neutral. If the brushes be slightly shifted from the live neutral position, the armature will revolve in the direction of the shift. Angular location of the brushes is necessary to the action of the motor. The amount of angularity affects the action and characteristics considerably, since it varies the relative number of field magnetizing conductors and energy or reacting conductors on the rotor.

The greater the shift from live neutral the greater the static torque, up to a certain point, but the lower the speed for a given load. Small angularity produces maximum pull out torque, large angularity produces maximum starting torque. A compromise position is used. Slight change of brush position makes considerable difference, the machine being very sensitive.

The repulsion motor has a series characteristic since the field strength, Fr, is proportional to the load current in the rotor. The motor has good starting torque with moderate current demand. Commutation is good

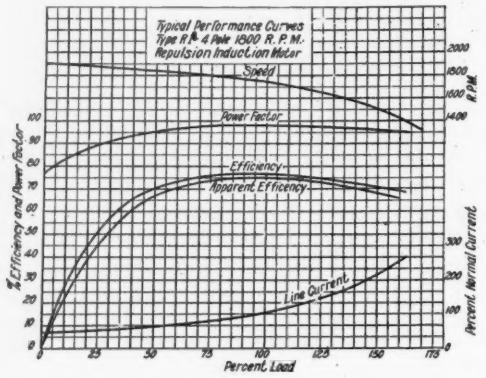


FIG. 9. CHARACTERISTICS OF REPULSION-INDUCTION MOTOR

while the motor is up to speed, but poor at starting. Motors of this type are usually noisy while accelerating. Since the starting torque is good, no auxiliary starting devices are necessary and the motors are well suited for remote or automatic control with float switch or other means.

A serious drawback to the repulsion motor is its series characteristic. Most applications demand a constant speed such as afforded by the induction motor. It was pointed out that the single-phase induction motor has poor starting qualities and requires an auxiliary

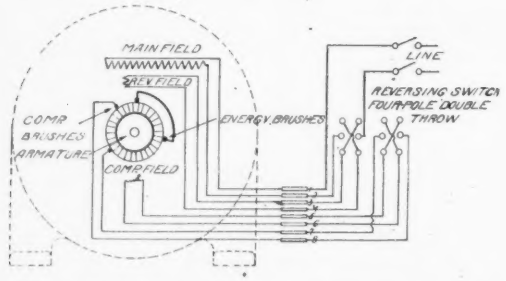


FIG. 10. DIAGRAM OF CONNECTIONS FOR REVERSING CONSTANT SPEED REPULSION-INDUCTION MOTORS

starting device and a clutch. Even with these features, little load can be accelerated and heavy current is taken. The repulsion motor, on the other hand, has fairly good starting characteristics. Motors have consequently been developed, called repulsion starting induction types, which start and run as repulsion motors until a predetermined speed is attained. An automatic switch then short-circuits the armature winding completely and the motor is transformed, in action, to the induction type.

This motor is built with a single-phase field winding distributed in the bore of the stator, this winding being connected across the line. The rotor is wound much like a direct-current armature, and is provided with a commutator, this usually being of the radial type to facilitate switching. This device is a centrifugal mechanism which short-circuits the commutator bars on their inner side and causes the brushes to be lifted from the commutator. One type of such centrifugal switch is shown in Fig 7. It is located within the rotor at the commutator end and consists of a steel sleeve, a centrifugal governor, and a spring, the whole being attached to the shaft. The sleeve carries a short-circuiting coil composed of a helical phosphor-bronze spring inside of which is a ring of flexible copper shunts. The flexibility of this device insures intimate contact with each individual commutator bar.

The governor rests against the end of the rotor core, while the short-circuiting sleeve is held against the governor by a spring. With the motor at rest, the short-circuiting ring is held away from under the commutator by the spring; but as the motor speeds up, the governor weights cause the sleeve to travel against the spring tension. At nearly full speed, the short-circuiting ring

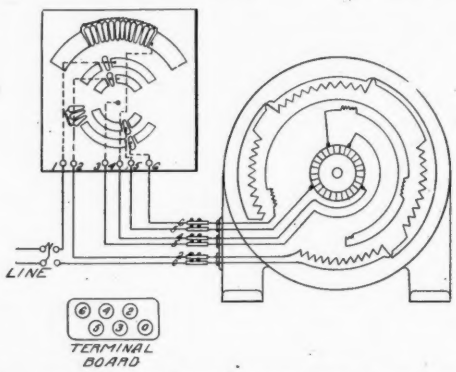


FIG. 11. DIAGRAM OF CONNECTIONS FOR VARIABLE SPEED REPULSION-INDUCTION MOTORS

moves under the commutator bars, short-circuiting them. At the same time, the brush holders are moved along the shaft away from the commutator, thus disengaging the brushes.

This double-acting motor, possessing high starting torque with moderate current input, is well adapted for pumps, air compressors or any drives where the full torque is required from standstill. The motor develops about 125 per cent full-load torque with full-load current at starting and can develop more than three times full-load torque a little less than three times full-load starting current. The pull-out torque is about 175 per cent full-load value. Since the motor develops so good a torque with moderate current input, it is well suited to automatic starting and is frequently employed for this service. In operation, the motor is essentially a constant speed machine.

Another type of so-called "repulsion-induction" motor employing no centrifugal switch, is in extensive use. This machine is provided with a smooth bore stator which carries not only the field winding, but also a so-called compensating winding which may be composed of a set of coils independent from the main wind-

ings and lying concentric with them in the central slots of each pole or it may simply comprise a portion of the main winding suitably tapped. The larger motors have the two separate windings. The rotor of this motor is similar to a direct-current motor armature, having a commutator similarly constructed, the mica being undercut. Two sets of brushes are carried, these being in service both during starting and running. One set of brushes corresponds to the short-circuiting brushes of the simple repulsion motor, while the other set, called the exciting brushes, have an influence which considerably modified the characteristics of the machine, giving it the composite name.

This motor is fundamentally a repulsion motor, the performance of which is modified through the use of the compensating winding and exciting brushes. The machine is shown diagrammatically in Fig. 8. The general action of the motor is similar to that of the repulsion type.

The function of the exciting brushes may best be explained as follows: In the discussion of the simple repulsion motor, the fact was pointed out that the rotor conductors, 4a, cutting the transfer flux, T, have generated in them a voltage in phase with that flux. In the machine shown in Fig. 8, the voltage generated in

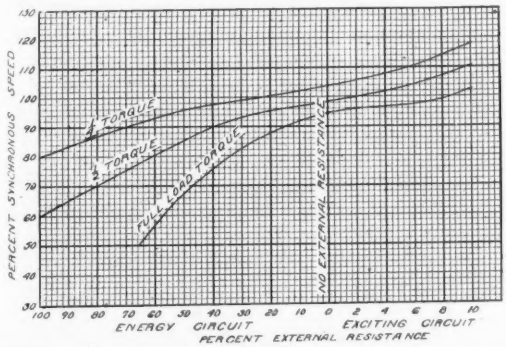


FIG. 12. SPEED CONTROL OF REPULSION-INDUCTION MOTORS

the rotor conductors through cutting of the vertical transformer flux, T, appears at its maximum under the exciting brushes. The presence of the short-circuited brushes materially increases the current flow in the rotor conductors due to the above generated or exciting voltage. This current aids the field, Fr, and is approximately in phase with it. The exciting voltage is proportional to the speed of the motor, being a generated voltage. The exciting current is proportional to the exciting voltage. The influence in strengthening field Fr is, therefore, most marked at high speed and least at low speed. Consequently, Fr is maintained at a much more uniform value than occurs in the simple repulsion motor. Through use of the exciting brushes, this machine has a fairly constant speed characteristic, regardless of the load.

The same flux, T, which generates the exciting voltage in the rotor, induces a voltage in the compensating coils, C. This voltage is in quadrature with the exciting voltage, one voltage being generated, the other induced. There is thus introduced into the exciting circuit a quadrature voltage which influences the magnitude and phase of the resulting exciting current. This, in turn, modifies the phase of the field, Fr, and affects the phase of the counter voltage of the machine and thus determines the power factor. It is possible so to proportion the voltages in the exciting circuit that the motor has a power factor of practically 100 per cent.

Discussion of the action of this type of repulsion-induction motor has brought out the fact that it is a machine with an approximate constant speed characteristic and that the power factor is near unity. In addition, it has good starting torque, developing full load torque with about 200 per cent current input and starting 2½ times full load torque if thrown directly upon the line, the current input being proportionately large. Motors above 5 hp. are usually provided with a starting rheostat to limit the starting current. The power factor at starting is high and acceleration is quiet, features not found in some other types of single-phase motors. Pull out torque is exceedingly high, the motor slowing down with overloads and acting much like a series motor. The characteristics of a typical motor of this design are shown in Fig. 9.

The direction of rotation of a repulsion motor depends upon the position of the energy brushes with respect to the live neutral, as already discussed. It is

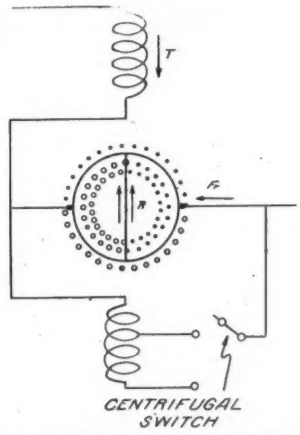


FIG. 13. DIAGRAM OF CONNECTIONS OF UNITY POWER FACTOR MOTOR

possible to change the direction of rotation of the repulsion-induction motor mentioned above by shifting the brushes from one side of the live neutral to the other. This is satisfactory only for motors operating in a single direction. Reversing service can be handled by placing on the stator an auxiliary winding which distorts or displaces the main winding, the brushes remaining fixed. This is equivalent, in effect, to shifting the brushes. The connections for a reversible motor of this type are shown in Fig. 10.

Motors of the repulsion induction design, as described, can be used for adjustable speed service where but a moderate range is demanded. If resistance be inserted in the circuit of the energy brushes, the effect is similar to increasing the rotor resistance of an induction motor or insertion of resistance in series with the armature of a direct-current motor, the speed being decreased in proportion to the resistance inserted and in proportion to the load carried. Insertion of resistance in the exciting circuit is like weakening the field of a direct-current shunt motor, increase in speed resulting. The connections of an adjustable speed repulsion-induc-

tion motor are shown in Fig. 11. The characteristics of a motor of this type may be seen from Fig. 12, showing the effect of insertion of resistance in the energy and exciting circuits respectively. The range of control runs from 40 per cent reduction below normal speed at full load with resistance in the energy circuit, to 10 per cent above normal with resistance in the exciting circuit.

The so-called "unity power factor" motor is a recently developed type having interesting features. It combines the starting characteristics of the series motor and the constant speed qualities of the induction motor, the scheme of connections being as shown in Fig. 13. The motor has a distributed primary winding and a compensating winding similar to that of the repulsion-induction motor. The rotor carries a squirrel-cage winding and also a winding connected to a commutator. The two windings are separated by a "magnetic bridge" if iron intervening between them. There are two sets of brushes on the commutator, the exciting and the short-circuiting brushes.

In a series motor, torque is secured through reaction of the rotor current upon the main field flux. In the

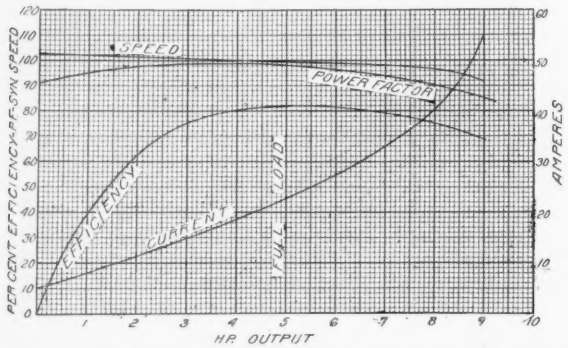


FIG. 14. CHARACTERISTICS OF UNITY POWER FACTOR MOTOR

unity power factor motor, the vertical main field flux is small because the current induced in the squirrel-cage winding opposes and almost neutralizes the magnetizing influence of the main winding. The commutated rotor winding, carrying the primary current, has a magnetizing influence in the horizontal direction. This flux reacts with the current induced by the main field in the squirrel-cage winding, to produce torque. The magnetic bridge of iron between the commutated and squirrel-cage windings enables the commutated winding to set up this horizontal flux without inducing in the squirrel-cage winding an opposing current to neutralize said flux. As the rotor speeds up, the current generated in the squirrel-cage winding acts, as in the simple induction motor, to establish the horizontal field.

The function of the compensating winding is to improve the power factor. At starting it is inoperative, being disconnected. At a given speed a centrifugal switch closes, bringing the winding into play. The compensating winding is similar to an auto transformer. Its voltage is applied across the exciting brushes and causes a current in the commutated winding of such phase as to modify the phase of the horizontal flux. This affects the counter voltage of the motor and improves its power factor. A tap in the compensating winding makes it possible to arrange the motor for unity power factor or for a leading power factor as desired. The characteristics of a motor of this type are shown in Fig. 14.

# Labeling Switchboard Equipment

By H. S. Knowlton

IN many quarters, the labeling of switchboard apparatus is looked upon as a needless refinement. It is maintained that switchboard operators become so familiar with the layout on each panel that they never look at designation cards or other information strips if these are used, just as towermen in railroad service soon pay no attention to working models of switch and signal installations under their control. The tendency to add instruments and other special features to switchboards, particularly in alternating current service, is so marked at present, however, that there is no little to be said in favor of complete markings of panel equipment, both on benchboards and on vertical installations.

A typical benchboard layout in a single-unit hydroelectric power plant lately visited may be mentioned. In a space about 5 ft. wide is mounted a three-section board containing nearly a score of instruments. A dummy bus occupies the sloping top of the benchboard, with a full assortment of switch buttons for remote-control service, knife switches associated with storage battery charging, station signaling, etc., and the apparatus also includes time-limit relays, rheostat handles and synchronizing lamps. Each instrument is, of course, properly calibrated in terms of the quantity which it measures, and it takes but a moment even for an outsider to grasp the use of most of the equipment, provided he is posted electrically. None the less, despite the reasonably thorough markings of the instrument dials, there is good reason in such a crowded installation to provide for more complete designations, in the interest of standardized reference and of cutting down the chances of delay in reading the right instrument under emergency conditions.

Granted that the operator may know intimately the use of each instrument and associated piece of apparatus on the board, it still follows that the marking of every switch and indicator with a neat tab or strip tends to make him surer of himself and to reduce by a real if small amount the mental energy required to deal with an operating emergency. If such designations cost enough to be considered, it might be regarded as a wise economy to do without them, but the expense of completely marking the apparatus of a switchboard is trifling in proportion to the cost of the board and its fittings. New men employed in such work learn their duties a little faster, without question, where complete markings are available, and even if the handling of the equipment tends in time to become second nature or subconscious, it is a wholesome arrangement to make to have all working parts of the board correctly and clearly tabbed. With such markings, there is far less excuse for mistakes which may be costly than where the operator has to depend even upon a well-trained memory.

# Circulation in Flooded Systems

DESCRIPTIONS OF EXPERIMENTS

IN a paper presented before the American Society of Refrigerating Engineers, A. H. Baer describes some interesting experiments which were made for the purpose of securing first-hand knowledge regarding the behavior of liquid ammonia evaporating inside of cooling coils. Flooded systems are classified under two heads, (1) the "gravity-flooded system" and (2) the "direct-flooded system."

## GRAVITY-FLOODED SYSTEM

UNDER the name "gravity-flooded system" are included all flooded systems of circulation in which the warm liquid ammonia from the receiver is forecooled to nearly the evaporating temperature before passing the feed valve.

This forecooling of liquid may be accomplished by passing it through a coil inside the accumulator (also known as liquid separator), the coil being exposed to the cooling action of return vapor. Another plan is to submerge this coil in the brine tank, and a third is to forecool the warmer liquid in a double-pipe cooler—supplied with other evaporating liquid. After the main

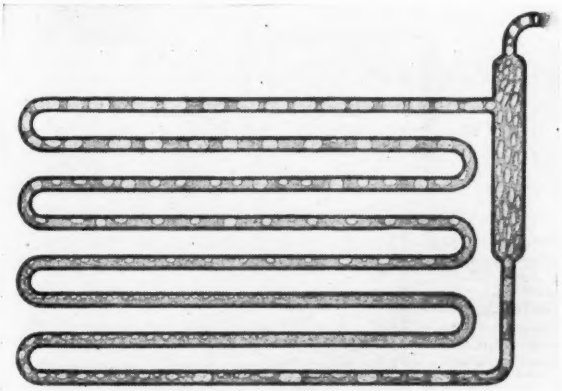

FIG. 1. GLASS MODEL USED IN FIRST EXPERIMENT

liquid has been forecooled it must pass through the accumulator and flow by gravity to the bottom pipes of the brine tank coils. In operation it is found that forecooled liquid ammonia entering the accumulator causes very little agitation there, because it requires little more heat to complete its cooling. In circulating through the cooling coils in the brine tank the desired refrigeration is effected, the resulting vapor passing up through the suction pipe to the top of the accumulator. Entrained liquid is separated out and returns to the tank coils, while the vapor continues on to the compressor in the usual manner.

## DIRECT-FLOODED SYSTEM

IN THE "direct-flooded system" the liquid, without forecooling before the feed valve, is fed directly into the lower pipe of the tank coils. The gas then formed in cooling the warm liquid must travel the entire length of the tank coils, along with the gas formed in cooling brine. This process accelerates the flow of the mixture of gas and liquid in the coils. The gas forms into bubbles, which drive all liquid ahead of them through the coils, so that there are alternately bubbles of gas and small bodies of liquid, all flowing towards the outlet.

To demonstrate the action of ammonia inside the apparatus, there was constructed a glass model of a tank coil and an accumulator, as illustrated by Fig. 1. By supplying these with liquid ammonia inside, and with ordinary hydrant water, also with ice water, on the outside, the behavior of the ammonia could be observed plainly.

## FIRST EXPERIMENT

IN THE MODEL shown in Fig. 1, the accumulator is placed low with respect to the coil, and the liquid drains directly to the lower pipe of the coil. First this coil was nearly filled with liquid ammonia. Being placed in the open air, evaporation of liquid and the gas flow through the coil was very slow because the glass tubes could not absorb the heat from the air rapidly enough; but when water was sprinkled over the coil, the evaporation of ammonia was so increased that in a few minutes

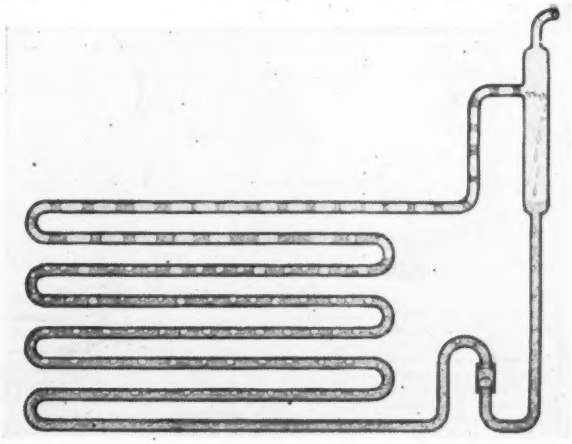

FIG. 2. MODEL USED IN THIRD EXPERIMENT

all had escaped from the top of the accumulator. Next the coil was partly filled with liquid. When hydrant water was sprinkled over it, the ammonia again got out of the top of the accumulator in a short time. Then the coil was partly filled with ammonia, and ice water used on the outside. In this case, the boiling of the ammonia was slower and its rate of ebullition could be observed more accurately. In general the direction of flow was, of course, upward and out from the upper part of the accumulator, but the gas in the lowest horizontal pipe flowed backward and up through the bottom of the accumulator. Even the vapor in the second lowest pipe passed out through the bottom pipe and up through the drain pipe of the accumulator, and in doing so it pushed ahead of it a large part of the liquid in the lower pipe, delivering it to the accumulator, raising its liquid level. While this was happening, the vapor formed in the remaining pipes was flowing upward, also pushing ahead of it a large portion of liquid and forcing this out of the accumulator, the consequence being that the gas and liquid boiled violently in the accumulator, so that nearly

all of the liquid was finally carried out through the top of the accumulator by the gas.

### Second Experiment

With the intention of increasing the liquid head so as to induce all circulation upward through the coils and down from the bottom of the accumulator, the glass model was reconstructed with the accumulator elevated.

When this apparatus was partly filled with liquid ammonia, and hydrant water used as before, the action of the ammonia was similar to that noted in the first experiment, with the exception that it took longer for the liquid ammonia to be wasted by being carried out of the top of the accumulator by the gas. The greater head of liquid failed to keep the gas in the lower pipes from flowing backward and up through the bottom of the accumulator.

### Third Experiment

The glass model was again changed in accordance with Fig. 2, by placing a check valve in the drain pipe from the accumulator.

To have the check valve visible, it was placed inside of glass tubing. A loop had to be put into the drain pipe, as shown, so that the small steel ball could lift and yet shut off flow against the tank coil. When this model was partly filled with liquid ammonia and the water applied as before, the evaporation of the ammonia was uniform throughout the length of the coil and all gas flowed from the lower pipes up through the entire coil. The gas formed into bubbles, which drove ahead of them the liquid, and as the bubbles approached the upper pipe and the outlet of the coils they became larger and the liquid bodies between them became smaller by reason of continual evaporation of some of the liquid while passing through the coils. At the inlet to the accumulator the small amount of liquid remaining between the gas bubbles readily fell into the accumulator and the vapor only passed from the outlet at the top.

This favorable result was to be expected after the experience obtained in the previous experiments, but there was no certainty as to the possibility of the liquid head in the accumulator lifting the check valve, allowing the vapor in the lower pipes to flow backward. The check valve was found to lift when the accumulator became partly filled with return liquid. When ice water was showered over the coil so as to approach the actual temperature of brine in a freezing tank, this small check valve intermittently lifted, permitting some of the liquid in the accumulator to flow down, after which it would remain seated until the level rose in the accumulator.

### Flooded System as Adopted

Figure 3 illustrates diagrammatically the system as it was then applied to an ice tank. The check valve here shown was especially designed for this purpose. The ammonia feed to the system was purposely arranged to favor lifting of the check valve. Repeated trials showed that the check valve regularly lifted whenever the level of the liquid in accumulator was raised. Since this variation in level cannot be very great, the check valve must operate frequently. We have found that a distance of from 3 to 4 ft. between the top pipe of the coils and the bottom of the accumulator is sufficient to provide the necessary liquid head for operating this valve positively and regularly without causing the liquid to fill up more than a few inches in the bottom of the accumulator itself.

### Double Accumulator System

When the apparatus shown in Fig. 3 was found to give good results the first conclusion was that the efficiency of an ice plant could be further increased by flooding also the water fore-cooler coils. Figure 4 shows the manner in which this was done. However, the results were not so gratifying as in the case of the ice tank. The higher temperature of the water caused a more violent boiling of the ammonia, so that the vapor went over to the compressor very wet. The latter condition could have been easily prevented, but it was also found that the high temperature of the fore-cooler had a tendency to create a higher back pressure, and that the increased efficiency of the fore-cooler coils was more than offset by the decrease in the efficiency of the ice tank coils on account of interference of high back pressure at the fore-cooler. This also could be avoided by means of a separate suction pipe from the fore-cooler to the compressors, but this arrangement is possible only in very large plants, where one compressor cylinder can be connected separately to the fore-cooler, or a separate small compressor used for this work. In the average plant the highest efficiency is received if the flooded system is used on the ice tank only, not on the fore-cooler.

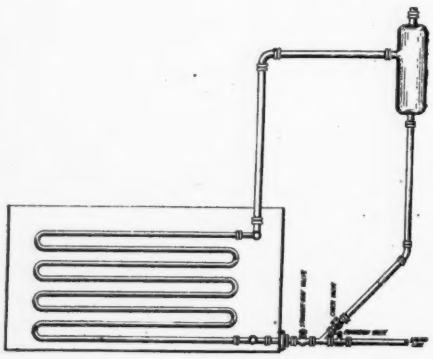

FIG. 3. DIAGRAM OF DIRECT-FLOODED SYSTEM

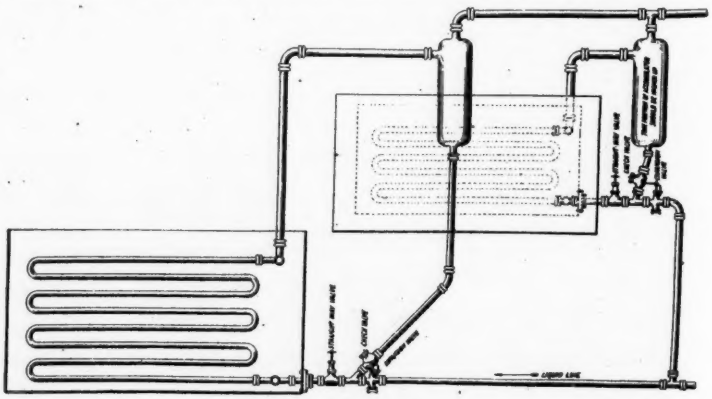

FIG. 4. SYSTEM WITH DOUBLE ACCUMULATOR

### Present Direct-Flooded System

The method finally adopted is the "direct-flooded system" taking the vapor from the accumulator outlet through the fore-cooler before it reaches the compressor. As this gas is usually very dry, it is unable to cool the fore-cooler water properly. Therefore, a booster expansion valve is attached to the suction pipe where it enters the fore-cooler coil, and a small amount of ammonia is expanded as needed. Thus the fore-cooling of the water is easily controlled by the engineer, likewise the frosting of the suction pipe. The ammonia feed to the ice tank coils is now usually connected to the lower header, on each side of the center, with the accumulator drain and check valve connected near the middle of the header. This design has been found to permit the check valve to lift easier.

This system has been used in at least 40 ice-making plants, both raw water and distilled water, during recent years and the direct-feed and check valve principle has proved so successful and regular in operation that it has not been necessary to change it in any way. The method of attaching the liquid feed to the header itself was adopted principally because of buildings with low head room where the accumulator had to be set rather low. It was found that the check valve works well even with very small head room if the liquid feed was attached further away from it.

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# Using the Wrong Material

By H. A. Jahnke

I BELIEVE a good deal of trouble complained of by some engineers that they have with some apparatus under their charge is caused by using the wrong material; this may be oil, rod or sheet packing, etc.

It seems to be the practice in some plants to make repairs with any material that may be on hand, then merely to do the work again in a short time, then the engineer or attendant is complaining that a certain apparatus gives so much trouble.

It is a much better plan to study the apparatus that gives trouble, then select the right material to repack or make repairs on it.

It may be well, therefore, to relate a few instances where the wrong material caused much trouble and expense.

In a certain manufacturing plant, a number of steam traps were in use and it used to be necessary to repack the joints in them about every 4 to 6 weeks on Sundays. The maker of these traps used 1/16-in. packing at the joints, after the traps were installed. A short time after, they started to leak badly; then the same kind and thickness of sheet packing was used to repack the joints, with the result that they had to be repacked after 4 to 6 weeks, at times less. I got tired of this and decided to use a different grade, also 1/32-in. thick sheet packing in place of the 1/16-in. as before. After this, it was only necessary to repack every 8 or 12 months, thereby saving much time and expense.

I remember an instance where a new air compressor was installed in a plant. With this machine came a small box of ring packing for each rod, which was recommended to be used on the machine by the maker, but after the machine was in operation it was found that the life of the packing was very short, so another make of packing was used which gave longer and better service.

Another case in mind was that of a flange union in the pipe line between an air compressor and air receiving tank. The flange is located next to the compressor. The gasket was made out of some rubber sheet packing and had to be renewed about once a week, due to high temperature and oil in the air. This work would take 2 men about 5 hr., as the receiving tank had to be removed, making it necessary to disconnect all pipes so as to get at the flange. We overcame this trouble the next time a new gasket was necessary. It was made out of asbestos sheet guaranteed to stand high pressure as well as high temperature and oil. This gasket was placed about 6 months ago and there is no sign of any leak. This shows that it is bad practice to use any old sheet packing for one and all purposes. It is better to use material which is guaranteed to give satisfactory service, also to meet the condition for which it is made.

We may go through many steam plants and find that one type of valves and fitting is used for one and all purposes. We find that heavy and expensive valves are used when a lighter and cheaper valve would do just as well, especially in such pipe lines or exhaust and low-pressure heating system.

Great care should be taken in the selection of valves and fittings for use in a power plant and elsewhere to get good service out of them with the least trouble. When ordering valves it is not only necessary to give the pressure, size and type, but it is also good practice to state in your order the service the valve is to be used for.

I have ordered valves of the composition disc type for steam service to find that the valve leaked badly after a few days' use. In taking the bonnet off the valve, it was found that the disc was nearly wasted away, due to the fact that the disc which came with the valve was not suited for steam service, being too soft, but was suitable for water or air, etc.

The steam valve and piston rings on a straight line steam driven or air compressor would make a groaning noise at the time when the steam regulator would act to make the compressor run full speed. After the compressor was up to speed the noise would disappear. In examining the piston rings, cylinder and steam valve several times nothing was found wrong; it seemed as if they were getting plenty of oil, so the sharp edges on the piston rings and valve were rounded off a little, but did not help the trouble any. Then I decided that we were using the wrong cylinder oil. As it was my idea that when the compressor was running idle there was more or less water in the steam due to condensation and this would wash the oil off the surface of valve and cylinder wall and piston ring, then when the steam regulator would act to cause full steam pressure on them these parts were dry.

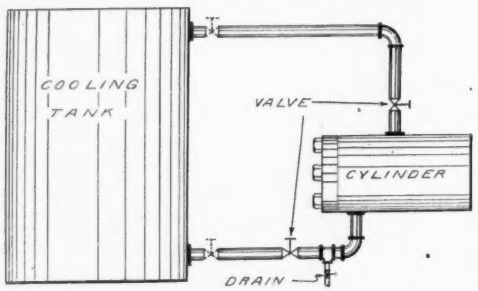
Then another grade of oil was used to suit the condition, which cured the trouble, as it has not been heard since.

# LETTERS DIRECT FROM THE PLANT

*Cash Paid For Ideas Accepted. Sketches Desirable.*
*We Make The Drawings*

## Draining Gas-Engine Cylinder Jackets

THE NECESSITY of draining the water jacket of a gas engine to prevent freezing and cracking is commonly known. The importance of having the combustion chamber thoroughly free of moisture is a point too often overlooked. A small amount of moisture in the combustion chamber makes starting extremely difficult and often impossible unless some means is at hand to dry this out. In certain types of engines, water may gradually ooze through the gasket between cylinder head and cylinder and enter the combustion chamber. Particularly is this likely to happen if the engine is standing idle for some time. Very often, engines are set up and piping installed with no provision for draining the jackets unless




LOCATION OF VALVES FOF DRAINING JACKET OF GAS-ENGINE CYLINDER

the whole cooling system is drained. A cutoff valve placed in the riser just above the cylinder and another in the inlet pipe just below the cylinder with a small cock or drain near it will prevent a lot of trouble. Precautions must be taken to see that these valves are opened and the drain closed when the engine is started. When the engine is idle, the valves may be closed, the drain opened and the cylinder kept free of water. If the piping and engine are exposed to freezing temperatures, these valves should be placed close to the tank and thus drain all of the piping and jackets without draining the tank. A little precaution in this regard is likely to prevent trouble and expense later on.

## Estimating Horsepower of Steam Engines

THE ENGINEER is often called upon to estimate the horsepower of a steam engine, knowing the various dimensions of the engine and the steam pressure, and either knowing or assuming the point of cutoff. These estimates must be made quickly, out "on the job," so to speak, away from horsepower tables, logarithm tables, and hand books, and it would be advisable to carry in one's mind certain constants that would make these calculations simple and rapid.

It is generally assumed that steam is expanded inside an engine cylinder according to Mariotte's Law of a perfect gas. This law is expressed by the equation—

$$p\,v = p_1\,v_1$$

where p and v are any pressure and corresponding volume, and $p_1$ $v_1$ are any other pressure and corresponding volume. The curve plotted from this equation is called an isothermal, because it is a curve of constant temperature.

Some authorities claim that the expansion is not an isothermal but an adiabatic one; that is, an expansion where no heat is transmitted. The equation of such a curve is—

$$p\,v^{1.06} = p_1\,v_1^{1.06}$$

As will be noted, this equation (and the same is true of its curve) does not differ much in value from the isothermal equation. It is probable that the actual expansion curve of an engine lies between the two, approaching the one or the other according to the condition of the cylinder, valves, piston, etc.

To calculate the horsepower of an engine, one must know the diameter of the piston, piston rod, length of stroke, number of revolutions, and mean effective pressure; all of these data but the last can be measured. The mean effective pressure must either be obtained from the indicator card or determined mathematically from the boiler or initial pressure and the point of cutoff. It is with this last condition that this article deals.

The formula used in determining the mean effective pressure, knowing the initial steam pressure and point of cutoff, is—

$$p_m = p_1 \frac{(1 + \text{hyp. log } R)}{R}$$

$p_m$ is the absolute mean forward pressure, $p_1$ is the absolute initial pressure, and R is the ratio of expansion in the cylinder or the number of times the steam is expanded. Thus, for cutoff at ¼ stroke, R is 4; for ⅓ stroke, R is 3; for ½ stroke, R is 2, and so on. The difficulty in using this formula is that it brings in the hyperbolic or Naperian logarithm of the value R. To find this number we must either have at hand a table of Naperian or hyperbolic logarithms or a table of common logarithms and a knowledge of the fact that the common logarithm of any number multiplied by 2.302,585,1 gives the Naperian logarithm of that number. As stated in the beginning these estimates are often called for when hand books and log tables are not available.

The idea is then to solve that part of the equation represented by $\frac{1 + \text{hyp. log } R}{R}$ for the several values of

cutoff found in practice. Carrying these in one's mind, it only remains to multiply the absolute initial pressure (gage pressure plus 14.7 lb.) by the value of the above expression to obtain the absolute mean pressure. From this absolute mean pressure, we subtract the absolute back pressure and the result is the mean effective pressure.

For example, we will work out the complete equation for the initial steam pressure of 100 lb. gage, and a cutoff of ¼, then $p_m = (100 + 14.7)\ \frac{(1 + \text{hyp. log } 4)}{4}$

$$p_m = 114.7\ \frac{(1 + 1.3863)}{4}.$$

$p_m = 114.7 \times .597.$

$p_m = 68.47$ lb. absolute.

If the engine is exhausting to atmosphere, then the absolute back pressure is 14.7.

$68.47 - 14.7 = 53.77$ lb. mean effective pressure.

It will thus be seen that the mean effective pressure for ¼ cutoff is about 60 per cent of the absolute initial pressure, a figure that can easily be remembered; and as all large engines have their rating based on 25 per cent cutoff, this value is particularly useful.

The value as solved, then, of this expression

$$\frac{1 + \text{hyp. log } R}{R}$$

is simply the percentage or ratio which the absolute mean pressure bears to the absolute initial pressure.

Below is a table of the more common points of cutoff with the corresponding values of R and of the ratio $\frac{p_m}{p_1}$.

| Point of cutoff | R | $\frac{p_m}{p_1}$ |
|---|---|---|
| ¼ | 4 | 59.7 |
| ⅓ | 3 | 70.0 |
| ½ | 2 | 84.7 |
| ¾ | 1.33 | 96.6 |

For approximate work it is safe to call these values 60, 70, 85 and 97, respectively, and these figures should be committed to memory.

Knowing the mean effective pressure, the horsepower is readily found, as all know, by the formula—

$$\text{I.hp.} = \frac{PLAN}{33{,}000}$$

or mean effective pressure times length of stroke in feet times area of piston in square inches times number of strokes per minute (2 multiplied by revolutions) all divided by 33,000.

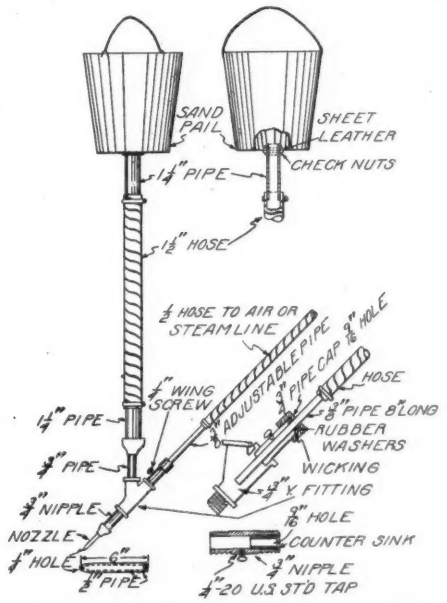
The above method of finding the mean effective pressure gives the theoretical value and does not correct for compression or clearance. Multiplying by the factor 0.96 allows for these corrections. To allow further for conditions in practice, certain authorities state that this result should again be multiplied by a factor ranging from 0.60 for small high speed engines up to 0.95 for the modern type of cylinder jacketed, cutoff valve compound engine.

The purpose of this article, however, was to determine the constants whereby recourse to the original formulas need not be had. C. A. J.

## How to Make a Sand Blast Outfit

A SAND BLAST OUTFIT which may be readily and easily made by any engineer is shown in detail in the accompanying illustration. Sand which should preferably be screened in order to remove from it any foreign matter which might cause the nozzle to clog is placed in the pail shown. From here it flows by gravity through the 1½-in. hose and connecting nipples until it reaches the Y-fitting, where it comes in contact with the air (or steam, if such is employed), which forces it out of the nozzle. Intensity of the blast can be regulated by adjustment of the air hose pipe in the Y-fitting.

A sand blast of this kind is particularly useful for the frosting of glassware, such as windows, electric light bulbs, etc. If desired to cut a name or figure on any




DETAILS AND ASSEMBLY OF SANDBLAST OUTFIT

piece of glass, cut out of a heavy piece of paper a stencil of the design desired, paste this on the glass and direct the sand blast against the exposed parts.

C. C. SPREEN.

## Peculiar Governor Trouble

READING THE ARTICLE of A. C. Waldron in the Oct. 1 issue of Power Plant Engineering, in which he states that the no-load and full-load stops on the governor were made too long, calls to mind two or three experiences in our plant.

The governors are of the inertia bar type similar to that shown by Mr. Waldron. The stops are on the inside rim of the wheel and bear against the weight on the ends of the bar as it moves to its extreme position in either direction. These stops are cast integral with the wheel rim and are bored out to take a piece of 1¼-in. round gum bumper which prevents the inertia bar from pounding the stops in starting and stopping. These gum bumpers become oil soaked, thereby destroying the rubber and requiring occasional renewal. In renewing these bumpers on one engine in particular, if they are cut a little too long the engine will race quite badly when the load is thrown off suddenly, due to the gum

preventing the bar from swinging far enough positively to cut off the steam. No trouble has occurred with the overload stops, as the engines are never loaded to the slowing down point, and trouble from racing frequently can be cured by cutting about ¼ to ½ in. off the gum bumpers. This in itself is a simple cause and remedy, but like many other small things might lead to serious accidents and it required considerable investigation to locate the cause of the trouble. J. C. HAWKINS.

## A Couple of Pointers

HE WAS AN ENGINEER of the old school, this old fellow who drifted into the engine room one Sunday when the load was light. I always make it a point to listen to the other fellow when time permits, so I'll pass along a couple of pointers that the old man gave me.

"I was in a little town the other day," began Dad, "that boasted of a light plant. As I was in the engineering game myself for several years, it is only natural that I drop into the different plants, get acquainted, and many times I am able to help the other fellow out of some little difficulty. However, the first thing I noticed as I went in the door was a sign that read:

THE ENGINEERS ARE TOO BUSY
TO LISTEN TO UNSOLICITED
ADVICE AND SUGGESTIONS

"Now, I'd never seen a sign like that before and was about to go out again, when the engineer came over and asked me if I knew anything about an engine. On my replying in the affirmative, he told me that in blowing out the old packing from the piston rod stuffing-

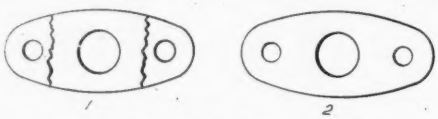


FIG. 1. BROKEN GLAND FLANGE

FIG. 2. STRAP MADE OF ½ BY 5-IN. IRON WAS PLACED OVER BROKEN GLAND AND HELD SECURE BY STUDS

box, the engine had rolled over and the crosshead had broken the flange off the gland, as illustrated in Fig. 1. He was up against it, as the saying goes, as it would take a week to get another gland. I told him not to worry, as I thought we could have the damage repaired in a couple hours.

"I took some measurements and inquired the way to the blacksmith shop, instructing him in the meantime to find his clearance, and then loosen and unscrew the piston rod from the crosshead.

"When I got to the shop I had the blacksmith cut a piece of strap iron about 5 in. wide and of the required length. A hole was then made a little larger than the diameter of the rod, and two additional holes drilled for the stud bolts. This looked like Fig. 2.

"I went back and after the strap had been put in place over the rod, we put the rod in the crosshead, packed the stuffing-box, put in the broken gland which was held fast by the strap, securely held in place by the studs.

"I then gave him a piece of advice regarding the sign that he had tacked up. 'And don't forget, sonny,' I told him, 'when you blow out packing, always put the engine on the head end center. You are always safe then from the engine turning over and doing any damage.'

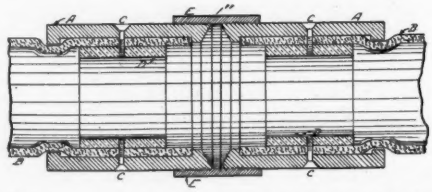
"He then asked me if I could do anything with a balky sight-feed lubricator. He said that the drops of oil were so large that the sight feed glass was always plugged up so that he could not determine the amount of oil that was feeding. I suggested that he renew the glass, make his gaskets just the right size so they could not bulge out and choke the openings, and reduce the size of the drop by putting a little piece of soap about the size of half a pea in the bottom of the glass.

"Without a word, he walked over, pulled the sign from the wall and beckoning to me, I followed him and watched the sign go into the boiler furnace."

JACK L. BALL.

## Repairing Ruptured Hose

A SUCCESSFUL way we hit upon of repairing a ruptured turbine hose using 200 lb. pressure in turbining our boiler, is as follows: Cut hose in two, cut out ruptured part, insert the hose ends into the hose connections as illustrated herewith, which parts we took from worn-out hose.



CROSS SECTION OF JOINT FOR HIGH PRESSURE WATER HOSE

We forced the hose ends into these, inserted the screws and by holding the clips in place, screwed up tight. We then had a special coupling made 1 in. in width to fit tight and screwed up flush. In 10 yr. experience with turbine hose, this is the only successful method I have ever found. C. A. DILLE.

## Linseed Oil in Boilers

I HAVE SEEN cylinder oil get into boilers from returns of the heating system, or open feed-water heaters where the oil separator is out of working order, due to being cleaned at irregular intervals, etc., but the following experience of getting linseed oil in the boiler, related to me some time ago by a friend, was new to me.

The plant consisted of 3 return tubular boilers in a paint-making plant. One day it was noticed that oil showed in the gage glass of one boiler. The boiler was placed out of service. When cooled off, it was found that the oil was of the linseed type used for paint. It was a puzzle how this oil entered the boiler.

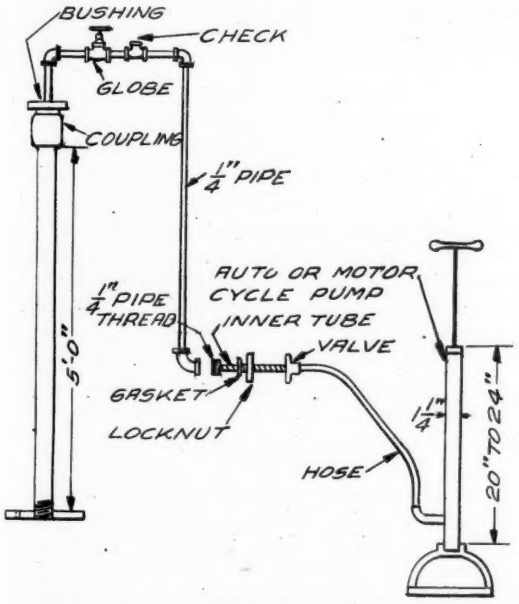
Some time after this, when the plant was idle for a day, the fireman, when about to start fire the next morning, noticed that the gage on one boiler showed oil in place of water. The boiler was cut out, and when opened, a large amount of linseed oil was found. Looking for the cause, it was found that the steam coil in one kettle located on the top floor, used for heating linseed oil, leaked badly, due to being rusted through in places, with the result that when the pressure was down in the boilers when idle, the oil found its way

into the boiler through the coil, by way of the return pipe of the steam coil. I thought this would be of value to some reader who has charge of a similar plant, to see that these coils are examined regularly and renewed in time that the trouble described may not occur.

H. A. JAHNKE.

## Securing Quiet Operation of Check Valves

WHEN check valves in boiler feed pump discharge lines hammer or knock, they may be entirely silenced by substituting the equipment shown, for the air chamber supplied with pump. Ten to fifteen strokes of the pump will supply sufficient air to silence the check valves for hours at a time, regardless of how badly they hammered before this outfit was installed. The valve to which the hose of foot pump attaches is taken from an old motor-cycle inner tube. The internal valve and spring are removed, the flange is filed down to the same diameter as the outside of a ¼-in. pipe, a thread is then cut on the flange end by means of a solid die, this is screwed into the ¼-in. elbow, a gasket is cut




METHOD OF PUMPING AIR INTO AIR CHAMBER

to fit over the small diameter of valve; when the lock nut is screwed up a tight joint is obtained. Air may be pumped into the air chamber at pressures as high as 150 lb. per sq. in. while the pump is running.

A. S.

## The Horsepower of Round Chimneys

INASMUCH AS most chimneys these days are round, it occurs to me that a chimney formula applicable solely to round chimneys would be highly desirable. I have done considerable figuring on chimneys myself and every time I have caught myself computing area of circles, extracting the square root thereof, etc. This is unnecessary.

The formula that is generally used is Kent's, and I have, therefore, thrown it into this form:

$$0.018{,}15\ (d^2 - 8.12d)\ \sqrt{H} = \text{hp.}$$

where d = the diameter of the chimney in inches at its smallest part;

H = the height of the chimney in feet;

hp. = the "boiler horsepower" of the chimney.

The formula is developed from this well-known form:

$$3.33\ (A - 0.6\sqrt{A})\ \sqrt{H} = \text{hp.}$$

where A = the area of the chimney's cross-section in square feet at its smallest part.

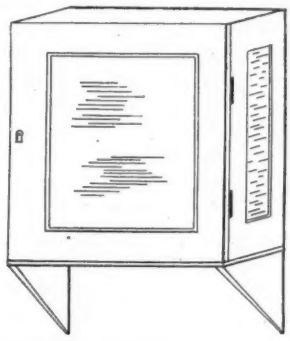
It will be observed that one of the "square roots" in the original Kent formula disappears in the formula as I have altered it, which is a good thing. It is much easier to multiply figures than to extract square roots.

N. G. NEAR.

## Protecting Steam-Flow Meters

WE HAD flow meters connected to each of our boilers, the instruments being supported by brackets attached to the front of the boilers. After being in service for some time, the exposure of these instruments to the steam, heat, coal, ash, dust, etc., always present to a greater or less degree in a hand-fired boiler plant, soon resulted in the accumulation of a heavy layer of dust, grit and dirt, making the instrument almost unrecognizable, and even clogging some of the working parts.

To remedy this, we had made up several small wooden cases, with glass door just large enough to contain the instrument, as shown in the accompanying



A CASING LIKE THIS, READILY MADE BY ANY ENGINEER, WILL PROTECT STEAM-FLOW METERS FROM THE DESTRUCTIVE ACTION OF DUST AND GRIT

sketch. These supplementary cases protected the instruments from the dirt and grit, while the dial was plainly accessible and visible at all times through the glass paneled front door. Glass panels were also placed at the sides of the case, so the ends of the instrument could be inspected.

The joints in the case were made dust-proof by using glue to supplement the wood screws used, and a heavy layer of belt was placed around the door frame connection.

In many cases, it will doubtless be found of advantage to provide this extra housing around instruments to prevent undue wear and tear, as well as to enable the highest accuracy to be maintained.

M. A. SALLER.

# Questions Answered and For Answer

*Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp*

## Engine Problems

YOUR ENGINE is leaking around the piston rod and gives two distinct knocks at the wristpin at each revolution, it is suggested: (1) That the crankpin may be out of line with the engine shaft; (2) wear and cutting in the main bearing, a poor job of babbiting, or a mistake in the adjustment may have thrown the engine shaft out of line, or (3) the piston and crosshead guides may not be parallel.

Describe carefully how you would test for each fault.

READER.

A. The fact that the piston rod leaks at the stuffing box, might or might not be caused by any one of the three suggested causes. Most engines leak at the rods more or less, and the two knocks at the wristpin also could be caused by them, although frequently noises which seem to be at the wristpin have their cause at an entirely different place.

The possibility that the crankpin is out of line with the shaft is quite remote, as modern machine methods preclude errors in this line. In all the writer's experience he has found but two instances where the crankpin was out of square. One was owing to the operator being careless in shimming up the crank disc when boring for the pin, and the other was on a 15 by 18-in. high-speed engine built by a reputable firm and which the writer was called upon to erect and later on, to remove and erect again.

In the first instance, the crankpin after being pressed into the hole, showed out of square about 0.025 in. in 8 in. (length of pin). The pin being turned at one setting was above suspicion and the hole was determined upon as the cause. The pin was pressed out again (not having been peened over yet) and saved for another job.

The hole was checked up by a master square and a straightedge and proved to be defective. The crank disc was then put on a mill, accurately shimmed and clamped and a light cut taken out of the hole where the error in previous work was now apparent. A new pin turned to fit the newly bored hole made a first-class job.

In the second instance, the engine being a direct-connected unit, was presumed to have been tested at the shop of the builder, and undoubtedly was, judging by evidence of wear at bearings, etc.; but when the engine placed in service at about half load or over, it developed a decided knock at each center and being enclosed and splash oiling, one could but look at the outside and conjecture.

The guards were removed and the oil drained off, oiling for the time being done lightly by hand. Under test the knock showed up in the crosshead and on running slow with a strong reflector thrown at the interior of the crosshead from the crankpin and in line with the shaft, the rod was seen to weave back and forth on the crosshead pin, there being considerable clearance.

The crankpin on investigation was found to be out of square, both by the application of the square and by the signs of wear. Being a small pin, about 4 by 5 in., a few good files, calipers and a steady eye eventually brought the pin out in fine shape. It was a small matter to scrape the boxes to fit, and the knock disappeared.

Naturally the only way to learn anything about a main bearing is to dig down and see. Wear may take place more or less rapidly, depending upon speed, hours of service, quality of bearing metal and oil, and nature of surroundings, whether dusty, etc.

Some engines (comparatively few in number) have a split collar on the shaft on the eccentric side of the bearing, set into a slight indenture turned in the shaft, and which prevents lateral motion of the shaft. If this collar be removed, it exposes the ends of the bearing shells when one can see just how thick the babbit is.

One can then also see the construction of the bearing and decide on what methods are necessary to remove the shells. Sometimes by loosening the eccentrics and sliding them along on the shaft, the bottom shell can be slipped out endwise by raising the shaft with a jack and supporting the disc on blocking; however, if the engine is a belted unit, brace the shaft well to prevent displacing by belt strain.

If the shaft has a solid collar, the bearing shells must be removed in the ordinary manner. With the best engines the lower shell is in two pieces, the inner one being turned concentric with the shaft, so that by raising the shaft 1/16 in., the shell can be rolled around the shaft and removed.

You can now examine both shaft and bearing for cutting and note if shells need re-babbiting. If there seems to be ample babbit metal in the shells, but the shaft is low in the main bearing, insert a shim under the lower shell, enough to raise the shaft the desired amount.

To test for a poor job of babbiting requires a little experience and good judgment. One cannot tell by looking at babbit whether it is well suited for the work at hand or not. There are several hundred formulas for babbit metal for various purposes, and considerable fraud is practiced by the unscrupulous.

It not infrequently happens that the babbit will work loose from the shell with use, owing to poor anchorage, dirty, greasy, or sandy castings, or both. To test for loose babbit, take a light ball peen hammer and tap lightly all over the babbited surface and where solid, the blow will be solid, but where the babbit is loose, it will sound like a cracked kettle under the blow.

For loose babbit there is no remedy but to re-pour. After removing old babbit, drill new anchor holes, quite

large and projecting at various angles, so as to hold the babbit better.

The proper way to test for the shaft's being out of square with the engine, is to remove the reciprocating parts and stretch a line through cylinder and guides centrally. Then by calipering, or tramming from the line to opposite sides of the crank disc, any difference will suggest which way to move the shaft to bring it in line again. If time will not permit this, a good straight-edge held against the back end of the cylinder and projecting in the same direction as the shaft and in the same plane, will provide a fairly accurate means of squaring up the shaft.

Then, with a steel tape laid on the edge of a board (to prevent sag), or even the edge of a good light board in place of the tape, measure from the shaft at the side of main bearing and also at the end, outside the outboard bearing, over to the straightedge, making accurate allowance for the difference in diameter of the shaft, if any.

To obtain greater accuracy, lay off on the straightedge from the center of the cylinder, in feet and inches, the distance from the center of the crankpin box (center of engine) over to the points on the shaft from which measurements were taken. Move the shaft as required to obtain desired results.

(3) Whether the cylinder and the crosshead guides are parallel or not (or in other words, in line) is another matter that is quite prevalent and can be aggravated considerably by a monkeywrench and a weak mind. Few engineers take the pains when adjusting crosshead shoes to train and learn if the rod is parallel to the slides or guides. Pistons as a rule naturally wear low in the cylinder; yet adjustments are generally made on the lower shoe to compensate for wear, thus tending to throw the rod much out of place. A rod in this condition will leak at the stuffing box in spite of all that can be done.

If bar or slipper guides are used, the same care must be used in making adjustments so as not to distort the rod from the true central position.

After all is said and done, it is, at best, but general information; each individual case presents problems of its own and must be dealt with "right on the job"; the engineer must give intelligent thought to whatever confronts him and there is little but what will yield to reason. G. H. WALLACE.

## Heat in Internal Combustion Engine Exhaust

ASSUME HAVING two internal combustion engines, one operated on gasoline and the other on kerosene, and each is carrying, let us say, 5 hp. In which exhaust will there be the more heat? J. M. S.

A. Your question about the heat in the exhaust of a combustion engine, is one which cannot be answered in a general way. It is somewhat like asking how much heat there is in the exhaust of a steam engine. It all depends on the way the engine is operated.

Kerosene contains more heat units per pound than gasoline, and as a rule, the gasoline engine works more efficiently than the kerosene engine, which would leave a greater amount of heat in the exhaust from the kerosene unit; but a little lack of care in adjusting the proportions of the mixture, the compression pressure and the timing of the ignition in the gasoline engine, might throw the efficiency in the other direction, so that there would be a greater amount of heat in the exhaust from the gasoline unit than from the kerosene.

All conditions being the same so far as adjustment for economy is concerned, kerosene exhaust will contain the greater amount of heat. A. L. R.

## Mercury Vapor Lamps

WILL YOU please give me some general information relative to Cooper-Hewitt mercury vapor lamps?

T. E. D.

A. The ordinary type of Cooper-Hewitt mercury vapor lamp, in which a column of mercury is rendered luminous by the passage of electric current, consists of a glass tube about 1 in. in diameter and 2 ft. in length, terminated by bulbs containing the (negative) mercury and (positive) iron electrodes. The hood above the tube contains inductance coils, a steadying resistance, an automatic tilting magnet and the necessary contacts. When the current is thrown on, the lamp is tilted, and as it drops back, the current follows the mercury through the tube and establishes a luminous body of vapor. The light is of a strong greenish cast, but steady, of relatively low intrinsic brilliancy, 10 to 11 c.p. per sq. in., and of high efficiency. The ordinary lamp gives about 300 mean lower spherical candlepower when worked at 3.5 amp. with about 192 w. at the terminals; in other words, it works at a specific consumption of about 0.67 w. per c.p.

Cooper-Hewitt lamps are essentially direct-current lamps, and when only alternating-current sources are available, it is necessary to employ a current rectifier.

A life of about 4000 hr. is claimed for the tubes of these lamps, with a candlepower decline of about 25 per cent in the first 1000 hr.

The light given by the low-pressure mercury vapor lamp is greenish blue, and is without red rays. This bars the lamp from use for many purposes. It has been found to be well adapted for use, however, in installations where color values are of little importance, as in print shops, warehouses, some factories, drafting rooms, etc. It has been found to have peculiar value in work where fine detail discrimination is required.

Some of the general advantages claimed for this type of lamp are, high efficiency, ease of operation and absence of strong shadows. On the other hand, some of the general objections are, color of light; flickering of light with alternating current; low power factor and deceptive appearance of surfaces illuminated.

In installing lamps of this type, limit circuits to one lamp or series of lamps, and use double-pole switches; avoid plug cutouts for 220-v. circuits and avoid armored cables and twisted cord or wires, as these, for some unexplained reason, are said to shorten the life of the tubes. With direct-current lamps, be sure that the polarity is right before starting. When mercury vapor lamps are used in places where inflammable gases exist, the spark of the automatic cutout hammer which releases the solenoid is dangerous and special lamps should be used in such places. O. H. H.

ONE OF the first instructions to the electrician is to keep his shirt sleeves rolled down so that his arms will not come in contact with live conductors.—The Travelers Standard.

# Problems For Discussion By Readers

*What Would You Do If You Had These Conditions To Meet?*

## Relocating Wristplate Marks

To RELOCATE the marks on the hub of an engine wristplate, as referred to on page 829 of the Oct. 15 issue of Power Plant Engineering, drop a plumb line down by the side of the plate, set it exactly vertical and make your central mark. Now, loosen the eccentric on the shaft and roll it around to the extreme of travel each way and with a pair of dividers measure and see if the wristplate moved an equal distance each side of the central mark. If not, adjust the length of the eccentric rod until it does. Then with the eccentric at the extreme of travel, you can replace your marks.

It is well to see that the rocker arm travels an equal distance each side of a plumb line falling through the center of its pin. Do this by adjusting the length of the eccentric rod and then equalize the travel of the wristplate by adjusting the length of the carrier rod. a, Fig. 2, is opposite b when the wristplate is in its central position. At the extreme of motion, a is opposite c and d. Do not try to equalize the travel of your

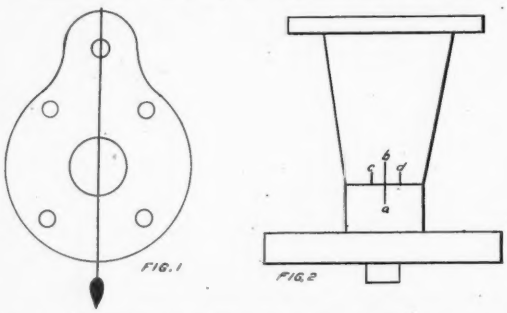



FIG. 1. METHOD OF PLACING WRISTPLATE IN CENTRAL POSITION

FIG. 2. A AS OPPOSITE B WHEN THE WRISTPLATE IS IN CENTRAL POSITION

wristplate first and the rocker arm afterward. If you do, you will doubtless get things badly snarled up. In making your marks, use a good sharp cold chisel and make the marks as fine as possible. I would file off the old marks so as not to be troubled with them again.

THE CHIEF

---

ENGINEERS can mark the wristplate by using a plumb bob and line, as shown in Fig. 3, setting the plate in its central position and by means of a small, narrow, sharp cold chisel placing mark a on hub of wristplate and also corresponding mark b on bracket. Eccentric rods should be properly keyed up and the eccentric loosened on its shaft. Then set rocker arm plumb when reach rod is engaged on wristplate. Now, adjust connecting rod until full side of the eccentric is down, keeping line a and b line and line; this will give approximate length of connecting rod. Turn the eccentric to extreme throw and note the travel of line a from b. Now turn the eccentric to its other extreme travel, again note the distance a travels from b. Make these two distances of travel from b equal by slight adjustment of connecting rod. With eccentric at extreme travel, make the marks c and d, and to correspond with a. This, when a is line and line with c or d, gives us the extreme travel of the wristplate.

Assuming E. B. P. already has the edges of the valves and ports marked, he may proceed to adjust the valves in the usual manner and secure the eccentric fast at proper advance. When ready for running, if it is possible put an indicator on your engine and make close adjustments of the valves.

It is also a good plan to mark external valve markings as shown in Fig. 4. This will enable one to make rapid and approximate adjustment without the inconvenience of removing the valve bonnets in case the eccentric slips or a rod becomes misadjusted. Proper adjustment can be made also with the engine hot and put back into service within a few minutes.

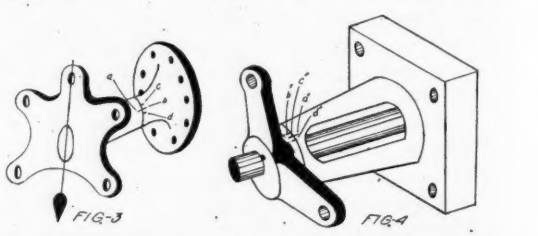



FIG. 3. METHOD OF CENTERING WRISTPLATE AS RECOMMENDED BY F. E. BACON

FIG. 4. VALVE HUBS AND BRACKETS MAY ALSO BE MARKED TO ADVANTAGE

External valve marking should be made neatly with a fine chisel and a light hammer. Care should be taken that they are made in line with valve stem and to register correctly at their proper position.

In making external valve marking, line a′ should first be placed on the bracket at a convenient location, then b′ should be marked on the arm so it will correspond with a when the wristplate is at its extreme travel, which gives the valve the most lap. Now add line c′ so as to correspond with a′ when the arm has moved so as to bring the valve line and line with the port. Then add d′ to correspond with a′ when the wristplate is at its other extreme travel. Marks like these should also be placed on the brackets of exhaust valves. Small steel stamping letters may be used to stamp "lap," "lead," "full port," etc., opposite of which the lines indicate.

F. E. BACON.

TAKE THE rear bonnets and remove the valves. With a sharp chisel mark upon their back end a line, touching the circumference of the valves, coincident to the steam edges of the valves, and also place marks in some convenient place on the valve housings representing the edges and width of the steam ports, and replace the valves. Place the swing plate and rocker arm in a vertical position, with crankpin on its dead center toward steam cylinder, and mark the swing-plate hub, prolonging the line upon the swing-plate bracket. Loosen the eccentric and rotate it, adjusting the eccentric rod so that the line upon the swing-plate hub vibrates equally distant each side of the line upon the swing-plate bracket.

After this, secure the swing-plate in its vertical position by inserting several thicknesses of emery cloth under the washer of the swing-plate stud and tightening the nut. Give the steam and exhaust valves their required lap, using for this purpose a pair of dividers and measuring from the mark representing the cutoff edge of the port and steam edge of the valve on the circumference. After the steam and exhaust rods have been secured for equal lap at both ends of the steam cylinders, release the swing-plate and advance the eccentric upon the shaft, until the line representing the edge of the left-hand steam valve has traveled beyond the incision representing the cutoff edge of the port indicating lead, and

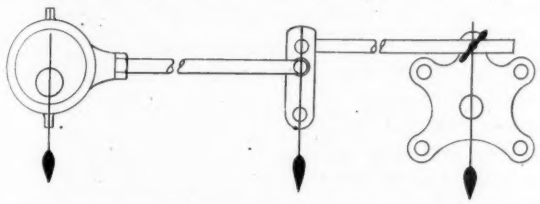


FIG. 5. PLACE ECCENTRIC IN VERTICAL POSITION AND PLUMB ROCKER ARM AND WRISTPLATE

secure the eccentric to the shaft. The engine should now be rotated and the marks upon all four valves carefully gone over, to ascertain whether the lead is equal at both ends and the valves have sufficient overtravel to prevent wiredrawing at early cutoff. Half-inch overtravel with 1/16 in. lead will be found adequate for the majority of the engines; the steam lap should be from ¼ to ⅝ in. with exhaust lap ranging from 7/32 to 1/16 in., depending upon the size of the engine and the amount of compression required. The lead of the exhaust valves should always be in excess of that of the live steam valves, so that just on the point of opening the live steam valves still have lap to prevent the blowing through of steam. This completes the setting of the eccentric, rocker arm, swing-plate, and steam and exhaust valves as far as can be done without the use of an indicator.

FRANK WELLS.

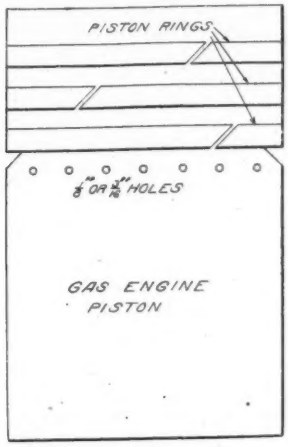
---

FILE OFF the old marks on the hub and wristplate and then place the eccentric exactly 90 deg. to the horizontal, plumb the rocker arm and wristplate, as shown herewith. With eccentric, rocker arm and wristplate in vertical positions, you are sure that the connections are the right length. Now turn the eccentric to its extreme position, i.e., on one center, and mark the wristplate and hub, both marks in line. Then place the eccentric on the other center and mark the hub and wristplate, these marks to be in line also. Mark the eccentric and eccentric straps and rocker arm, at the same time, for future reference. Those two marks already made indicate the maximum throw of eccentric and wristplate. Now the center of travel between these two extreme marks will be the center, with eccentric, rocker arm and wristplate vertical.

C. M.

## Preventing Gas Engine from Pumping Oil

C. E. N. WANTS to know how to stop his gas engine piston from pumping oil by the pistons. He might bevel the crank-case side of the lower ring groove and drill holes through the piston, say a ⅛ or ¾-in. hole every 2 in. The ring scrapes the oil off the cylinder wall and it runs through the holes to the inside of the piston and to the crank-case. This is the way they fix automobile engines that pump oil.




METHOD OF FIXING GAS ENGINE PISTON TO PREVENT OIL IN CYLINDER

I think his rings are not tight, also perhaps the cylinders are worn. In all probability the new rings are no better than the old; this happens quite often if the work is not well done. I ran a Westinghouse steam engine once that had leaky pistons; it would pump 4 gal. of oil up through the cylinders and out the exhaust in 10-hr. run.

J. O. BENEFIEL.

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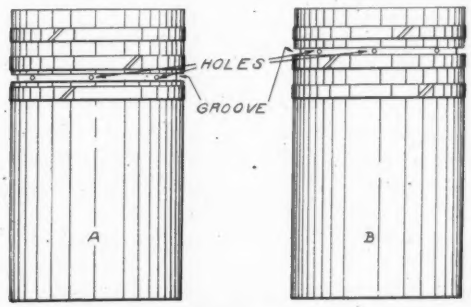
FOR THE INFORMATION of C. E. N. of the West Virginia Traction and Electric Company, I will say that




METHODS OF PREVENTING OIL FROM REACHING UPPER PART OF GAS ENGINE CYLINDER

having had considerable experience with gas and gasoline engines in which the oil would work above the rings,

causing the trouble mentioned, I have succeeded in overcoming it as described herewith.

The pistons were removed and in the space between the lowest two packing rings a groove was turned about 0.125 in. deep and wide. Holes the same diameter were drilled around the piston in the groove about 1 in. apart, as shown. While this remedied the trouble in one cylinder and resulted in less carbon in the others, it was felt that it was not enough; accordingly, the piston was removed and the second packing taken out. A groove was turned in the space occupied by the removed rings as illustrated. The top edge of the groove was cut back to a depth of about half the thickness of the packing ring so that the ring was not without support on that side. Holes were drilled in this groove as described above. When assembled, no further trouble occurred with loss of oil and the results encountered by C. E. N.

Another instance, where the cylinders were badly worn and there was no time to do a proper job of reboring and fitting new pistons, the pistons were put in a lathe and the inside chamfered off. This entirely overcame the difficulty. Care and judgment in each case must decide which to do and to what extent it is to be carried, because it is quite possible to reduce the oil in the cylinder to such an extent that enough will not work up to help seal the rings to make them gas-tight, although there is enough oil to lubricate the cylinder.

P. E. M.

## Marking Valve Gear; Who Is Responsible?

FOR THE benefit of E. B. P., who inquires in regard to marking his wristplate, I suggest that he try the following:

Figure 1 shows the wristplate, its support and the extreme positions of travel. The shoulders A and B on the wristplate are to limit the travel of the wristplate when the valves are moved by hand and thus prevent any valve gear parts from damage and, of course, is arranged for a greater travel of the wristplate than given by the eccentric.

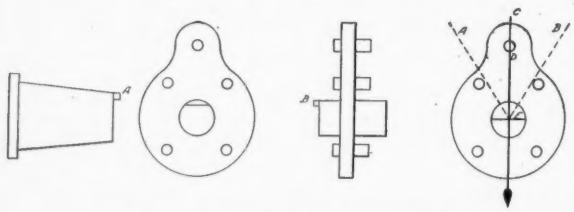


FIG. 1. WRISTPLATE AND SUPPORT

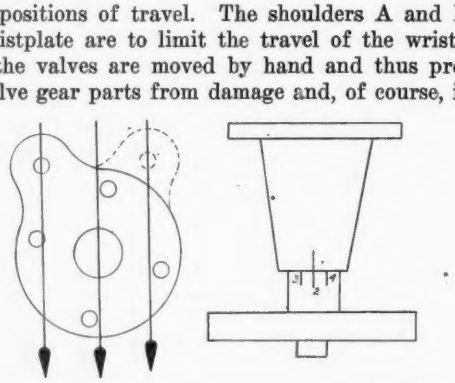


FIG. 2. LOCATING MARKS ON WRISTPLATE

If E. B. P. will cause the eccentric to move the valve arm equally each side of its center, then so adjust the length of the carrier or hook rod that a plumb line dropped from C, Fig. 1, will cut DE in the center when the eccentric is on the quarter, the wristplate will be plumb and in the center of its travel.

Then put a straightedge or small square along and parallel with the axis of the wristplate support, let it project onto the hub of the wristplate, making a mark on both support and hub, as 1, 2, Fig. 2.

Now turn the eccentric to its dead center, which will move the wristplate to its extreme of travel when moved by the eccentric. Make another mark on the wristplate hub with the square as a guide to coincide with the line on the support.

Turn the eccentric to its other dead center and make another mark on the hub to line up with the one on the support and these are to be your marks when squaring the travel of the valve motion.

In reply to R. B. as to who is responsible for the plant, I should say that there is no doubt that, in case of accident, the courts would hold both the officers of the company and the engineer as responsible. The thing for an engineer to do when encountering such conditions of indifference on the company's part is to get another place and bring the conditions existing to the attention of the police department, who, in the interest of public safety, ought to compel the conditions to be made safe.

RECEIVER.

---

IN ANSWER to the question as to who will be responsible for boiler explosion where the owner has been repeatedly notified and warned that the boilers are unsafe, and still continues to operate them longer than a reasonable time required to make repairs or install new ones, I believe that the courts have held in numerous cases under the Workingman's Compensation Law and other laws, that where any accident occurs that can be traced to negligence on the part of the owner to take every reasonable precaution to guard against danger, that he is fully liable for the results of any accident that may occur from this cause.

The law, I believe, would compel the owner to pay the cost of any accident that occurs, and would probably cost him 10 to 20 times as much as it would to repair the boiler or install new ones.

That, however, is not the main point. It makes no difference who is responsible; if any piece of machinery is operated when it is known to be defective and liable to explode or otherwise break, causing injury or possibly loss of life to the engineer and others, placing the responsibility (not infrequently on the dead man who cannot defend himself) does not make it any the less a criminal offense to mankind.

No job was ever found in any small central station plant, or in any other plant for that matter, that was good enough, or paid wages enough to warrant the engineer knowingly taking his life in his hands to operate a boiler plant under known dangerous conditions; and any man who will do it is lacking in gray matter, to say the least. I know that it is not comfortable to be out of a job, especially under the present cost of everything; but I believe it is preferable, temporarily, until something else can be found, to being in danger of being blown to atoms or maybe suffering for months as the

result of an explosion. Money as damages in a case of this kind is nothing.

In a case of this kind, where the owner persistently refuses to rectify the dangerous conditions stated, I believe that accident could be prevented by the engineer in at least two ways, either of which in view of the facts stated would be justifiable. The first is for the engineering, in quitting, to warn his successor (and, of course, he will quit when he discovers the dangerous conditions if repairs are not made in a reasonable time) of the dangerous conditions, and thereby prevent the owner from getting an engineer; the other plan is to take a hammer and knock holes in a few of the tubes, making repairs necessary before the boiler could be operated. I do not approve of this as a rule, and it would cost the engineer his job, which would be better than losing his life; but in this case the owner evidently needs drastic action to wake him up to his responsibilities, and the man who did it could go his way feeling assured that he had saved someone's life and limbs, and in view of the facts stated I believe the courts would acquit him of committing any crime if ever it was brought before the court's attention.

This case is fortunately one of the few exceptions that can be found in various parts of the country, especially where the inspection and license laws are slack; and when any power plant owner refuses to heed warnings which, if not heeded, are apt to cause loss of life and limb, he needs a jolt that will shake him from foundation to dome, and the sooner he gets it the better.

J. C. Hawkins.

(Rather than lose his reputation by knocking holes in a boiler, the engineer could have an injunction served upon the owner and let the courts settle the trouble.—Editor.)

---

In reply to R. B.'s inquiry, on page 829 of the Oct. 15 issue of Power Plant Engineering, as to the proper course for the engineer to pursue in the case of his employer refusing to retube a defective boiler, I believe the engineer should call his employer's personal attention to the matter and fully outline the danger to which he is subjecting both property and life. If this does not suffice, the engineer would be more than justified in refusing to operate the defective boilers and should fully warn any other person who might attempt to operate them; for, should he continue to operate them knowing their dangerous condition, he would be in a measure responsible for any damage which might result through the failure of the known weakness. And it is doubtful if he or his dependents could recover any damages should he suffer injury or death through the failure of the known defect. Some may recommend a little direct action in case all other means fail, for surely a cold chisel and hammer would soon produce an effect which would render the operation of the defective boilers impossible until the weakened tubes were replaced.

A. C. McHugh.

---

## Is the Indicator at Fault?

I note in the Oct. 15 issue, page 831, that E. C. D. takes exceptions to most of my expressed opinions in the July 15 issue relative to indicator diagrams. Of course, different people have their own ideas as to the cause of distorted diagrams. Sometimes two or more different causes may produce the same result, and merely looking at the diagram will not always settle the question, as to which is the actual cause of the revealed trouble. For the past 25 yr. I have handled numerous indicators and have analyzed many diagrams, and I am still engaged in that kind of work; so I ventured an opinion of the diagrams referred to, and presumed that others would also send in their opinions, and thus would there be a consensus of opinion, which is just exactly what the average reader requires.

E. C. D. takes me to task because I said that the instrument must not always be blamed for the production of a freak diagram, and that an ill shaped diagram may be produced with a first class indicator. What I mean is just this: If an indicator is handled roughly by a person not accustomed to that kind of work, he may produce almost anything in the way of distortion. For instance, he may forget to blow out the condensation from the indicator cylinder and connecting piping; he may neglect to oil the various parts of the instrument, particularly the piston, and so it may stick slightly, even though the piston movement may have been what we call perfect when the indicator left the salesrooms of the manufacturer; then, too, he may press too heavily against the pencil point, and so restrict the movement of the entire mechanism. Surely the indicators could not be blamed for all this, and yet I have seen the very things that I have just referred to, not because the indicator could not be depended upon, but because it had not been used in the way that all such semi-delicate instruments must be used, if correct results are to be obtained. Therefore, not knowing who produced the diagrams in question, nor how they were produced, I simply ventured an opinion for what it is worth. My conclusions may not be correct, but that may be true of any other opinion. Nevertheless, hearing the different expressions of opinion may enable the original questioner to arrive at an opinion of his own, backed up by his practical knowledge of the engine from which the diagrams were obtained.

Now, with regard to the proper spring to be used, the makers of indicators furnish a table for that very purpose. But it seems to me that judgment on the part of the operator may be brought into play in the selection of a spring. I would rather be on the side of a stiff spring than on the side of a weak spring; that is, I would rather use a 100 spring for 150 lb. initial pressure, than use a 70 spring, for the same pressure. Here again is a matter of opinion. An indicator requires a nice degree of handling, in which is to be considered not only pressures, but also length of diagrams to be produced, and the speed at which the engine is run.

Finally, I would say that the design of the steam and exhaust passages and ports in an engine cylinder, and the size of the main and exhaust steam pipes, have an influence on the steam distribution, and it will be shown, to a certain extent, at least, by the tracing of an indicator diagram.

E. C. D. asks for further comments, while sitting in judgment on those already given. He should be quite sure of his ground before condemning any opinion that may have been given, else those who might be of service to him will be disinclined to do any more. Differing from an opinion does not necessarily mean belittling that opinion.

Charles J. Mason.

# POWER PLANT ENGINEERING

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CONTENTS


For the Comfort of the Guest. Illustrated..... 881
Bearings—I ..... 884
Power Plant Instruments as an Investment—II. By M. A. Saller. Illustrated..... 886
Bagasse Burning. By A. Guell..... 890
Tube Bender. Illustrated..... 890
Single-Phase Motors—II. By Gordon Fox. Illustrated.. 891
Labeling Switchboard Equipment. By H. S. Knowlton.. 894
Circulation in Flooded Systems. Illustrated..... 895
Using the Wrong Material. By H. A. Jahnke..... 897
Letters Direct from the Plant: Draining Gas-Engine Cylinder Jackets. Estimating Horsepower of Steam Engines. How to Make a Sand Blast Outfit. Peculiar Governor Trouble. A Couple of Pointers. Repairing Ruptured Hose. Linseed Oil in Boilers. Securing Quiet Operation of Check Valves. Horsepower of Round Chimneys. Protecting Steam-Flow Meters.. 898
Questions Answered and for Answer: Engine Problems. Heat in Internal Combustion Engine Exhaust. Mercury Vapor Lamps..... 902
Problems for Discussion by Readers: Relocating Wristplate Marks. Preventing Gas Engine from Pumping Oil. Marking Valve Gear; Who Is Responsible? Is the Indicator at Fault? Illustrated..... 904
Editorial: A Suggestion..... 908
January 1, 1918, Specialized Issue..... 909
New Westinghouse Circuit Breakers. Illustrated..... 910
Ferrochem. Illustrated..... 910
Practical Reference Tables: Diagrams for Determining Steam Consumption of a Perfect Engine. Water Rate of Condensing Engines with Varying Degrees Superheat. Steam Consumption of Poppet Valve Engine with Superheated Steam. Friction Loss and Velocity of Water in Pipes. Duty and Coal Required for Pumping Engines..... 911
News Notes ..... 913
Catalog Notes ..... 913
Trade Notes ..... 914


## A Suggestion

Under ordinary conditions, the sending of cards of Christmas and New Year greetings is commendable and in line with the real spirit of the season. At this time, however, all energies are needed in directions which count most to help win the war, and the co-operation, particularly of those business firms which in the past have customarily sent cards of greeting to their business friends, may well be exercised by placing the money which would so be spent for printing and postage, at the disposal of some relief organization, such as the Red Cross or the Y. M. C. A., for the benefit of our men who are in the service.

Each individual or firm may spend but little, and it is not desirable that the individual sending of greetings be discontinued, but in the case of business firms, it is largely a formality which will not be missed by those who might receive the cards, and the several hundred thousand dollars which, in the aggregate, would be made available for necessary work, would be a large and helpful contribution to such work.

One activity which needs strong support is that of the Playground and Recreation Association in carrying on the War Camp Community Recreation Fund. The problem of cities and towns near the great army camps is a serious one. Naturally, in their spare time, the soldiers wish to get away from camp somewhat, and if they go to town, it becomes a question what they will do. If no provision is made for healthful social entertainment and recreation, the tendency may be for the soldier on leave to take such diversion as may be offered, and certainly will be offered unless suppressed by the civil and military authorities, in the vicious resorts. On the other hand, in many places the burden of trying to provide reasonable recreation centers for a large camp is a serious one for a town or small city. It needs the co-operation of the entire country.

It is estimated that $3 is needed for each man in our war camps to carry on this work successfully, and provisions have been made to take care of the work through the agency of the Playground and Recreation Association of America as fast as funds can be provided. The work that is to be done is the building of community club houses outside the camps, the supplying of trained leaders to organize the activities of these club houses, the providing of moving picture and theatrical performances, including amateur entertainments given by the men themselves, appropriate parties at which the women and girls of the community may help to take away somewhat the feeling of isolation which soldiers in camps naturally have, and the arranging of athletic contests and sight-seeing and recreation trips for convalescents.

This work is essential in order that our soldiers may be sent forward in good spirits and good health, and we trust that those who in the past have spent money in the sending of holiday cards as a matter of form, to those with whom they have not close, personal friendships, may divert that money to this or other form of vital helpfulness to the men in the camps, and in this way carry out more truly the real Christmas spirit.

# January 1st, 1918 Specialized Edition

## STEAM TURBINES

DEVELOPMENTS in the field of application of Steam Turbines have rendered it desirable to place before power plant engineers a comprehensive and up-to-date treatise on this type of prime mover. It is for this reason that the January 1, 1918, number of Power Plant Engineering will be devoted to a thorough discussion of this important subject.

From it, engineers and all those interested in power plant equipment will be able to gain not only a most thorough knowledge of the underlying principles of operation of the steam turbine, but also information relative to the most approved methods of installation and operation.

### Impulse and Reaction

Difference of action in these types will be clearly explained and the conditions stated for best efficiency in each type. Changes in pressure and velocity will be analyzed, showing the reasons for staging, function of nozzles and guide vanes, and the reasons for difference in staging in the two types. Action in combined impulse and reaction turbines will be explained, with the reasons for such practice.

*Arrangement of Turbines* will cover the reasons for and mechanical arrangement of vertical and horizontal turbines for single flow, double flow, bleeder, exhaust and reversing, showing where and why each is used. Typical placing of nozzles, stationary and guide vanes will be illustrated, the proportioning of number of stages discussed, methods of connecting to steam supply and to condenser described and provision for counteracting end thrust.

### Turbine Details

Different elements will be taken up at length for treatment.

*Nozzles*, the relation of form to pressure drop; shapes and distribution for impulse and reaction working; desirable form of jet and the materials used and manufacturing construction.

*Blading*, shapes for reaction wheels and for stationary and moving vanes will be shown with the principles governing the curvature, angles and thickness. Also shapes and proportions for buckets in impulse types will be given consideration.

*Wheels*, including shape of disks, mounting on shafts, mounting of blading, diameters of wheels and lengths of blading for different stages.

*Blade Rings* will be described, showing the way that guide blades are held in place, attachment of rings to casings, and methods of preventing leakage between stages.

*Shaft Construction* will treat of static and running balancing, bearings, lubrication, construction for small and large capacity units, material and methods of packing to avoid leakage.

*Governing* includes the main speed regulation by throttling, multiple nozzles, or intermittent blast; use of hand controlled nozzles; mechanism of control by mechanical, electrical and hydraulic devices, either direct acting or through relays; over-speed and over-load governors; and the mechanical arrangement on shafts or for external drive with details of devices for speed changing.

*Casings* for vertical and horizontal types will be illustrated and the requirements discussed for strength, inspection, easy repairs and economy in manufacture.

*Foundations* serve two purposes, to support the machines and prevent vibration. Requirements for each will be given, including shape, size, materials, amounts needed and methods of construction.

*Reducing Gearing* is needed for certain conditions with high-speed impulse turbines and for driving direct-current generators. The types of gearing used will be described and methods of overcoming side and end gear thrust.

### Turbine Economy

Factors which affect economy, such as, pressure, superheat, wetness of steam, vacuum, drop in each stage, shape of nozzles and blades, size of unit, will each be considered and their effect on steam consumption shown, so that the reader may judge how much a change in conditions or in design will affect the operation of his machines.

*Condensers* are needed. Why? This question will be answered at length, showing the gain to be secured from high vacuum and what is required in surface, volume, cooling water and auxiliaries to secure high vacuum.

*Regenerators* are used chiefly where the supply of steam to a low-pressure turbine is variable to store the surplus of heat during excess periods and furnish heat when there is deficiency.

Various forms used will be described, the range of temperature and pressure allowable in the regenerator discussed and requirements of surface and volume for satisfactory action.

### Commercial Descriptions

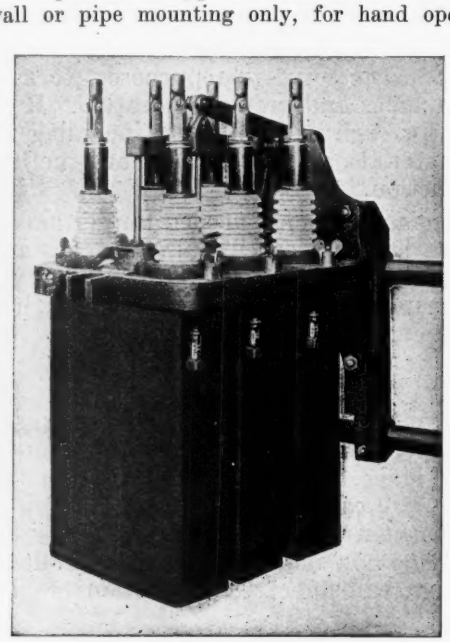
Details of different makes of turbines will be treated at length, giving a clear understanding of the construction, adjustments, usual repairs and replacements, inspection and overhauling and points to be looked after in operation.

# New Westinghouse Circuit Breakers

TO its line of Type B oil circuit breakers, the Westinghouse Electric & Manufacturing Co. has added 2 new types of breakers. These are designated as type B-2 and B-3, and are for use on alternating-current circuits up to 23,000 v. Type B-2 breakers have a carrying capacity of from 300 to 2000 amp, while type B-3 has a capacity of from 300 to 1200 amp.

Distinctive features of this line are rigidly clamped porcelain pillar bushings, self-cleaning butt brush contacts, auxiliary arcing contacts and spring-accelerated opening. Due to careful design, these are the most compact single-frame breakers produced.

Type B-2 breakers are furnished for panel-mounting, hand operation, or for wall or pipe-frame mounting, electrical operation. Type B-3 breakers are furnished for wall or pipe mounting only, for hand operation



NEW WESTINGHOUSE CIRCUIT BREAKER

through bell cranks, or for electrical operation. For both types, tripping may be either automatic or by hand. Hand-operated breakers are actuated by a handle projecting through a cover-plate on which is mounted the automatic trip coil (if any). When the breaker is electrically operated, the trip coil is mounted on the face of the panel. Remote control breakers operated by bell cranks and rods are provided with a spring to assist the force of gravity in opening. A dashpot brings the moving parts to rest without shock.

When pressure is brought to bear on the main contacts, as the breaker closes, the bent copper leaves of the members wipe across the plane stationary contacts, thus ensuring a solid metal-to-metal contact. Arcing contacts consist of a copper-tipped spring plunger mounted on the moving element, which bears on a copper stud on the fixed element. Since this contact is outside the main contacts, the arc is forced away from the latter.

Full rated current can be carried by the circuit breakers continuously with a maximum temperature rise of conducting details of 30 deg. C. above atmosphere; of coils, 50 deg. C., and of all other parts not greater than 50 deg. C.

Tanks are of lap-welded sheet steel, lined with micarta and allow ample space for oil and air above the contacts. Type B-3 breakers are provided with specially designed baffled vents.

These circuit-breakers are furnished for single-throw service only. Where double-throw service is required, two breakers are arranged to interlock so that they cannot be closed simultaneously.

# Ferrochem

THE invention of the steam boiler brought with it two annoying and expensive problems that chemists and engineers have been endeavoring to overcome for a great many years. Scale formation and the corrosion and pitting of the boiler metal have been the incentive for tireless labor and countless hours of time in experimental work. Many methods have been devised and used for the elimination of scale and for the prevention of corrosion, consisting principally of chemical treatments of the feed water as re-agents or through turbine cleaners to break up the hard scale after it has formed in the boilers.

There now comes into the field a boiler feed water treatment known as Ferrochem, which, it is claimed,

FERROCHEM MACHINE

solves both the scale and corrosion problems by treating the water mechanically before it enters the boiler. This is done by a machine which is attached to the feed water line in such a way that all of the water passes through it before entering the boiler.

The machine is made of an alloy of extremely sensitive metals, which is operated automatically by the water as it is pumped into the boiler. Its action causes a liberation of fine particles of the metal which attack the scale-forming salts and acids and prevent their cementation to each other or to the exposed surfaces of the boiler. Existing scale in the boiler is also softened and loosened, so that it falls off or is easily removed with a wire brush or a flow of water from a hose.

No new principle is involved in this treatment of boiler feed water as is shown by the many patents that have been issued in this and other countries. The Ferrochem process differs from these both in composition of the metal that is employed and in its application. The

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps

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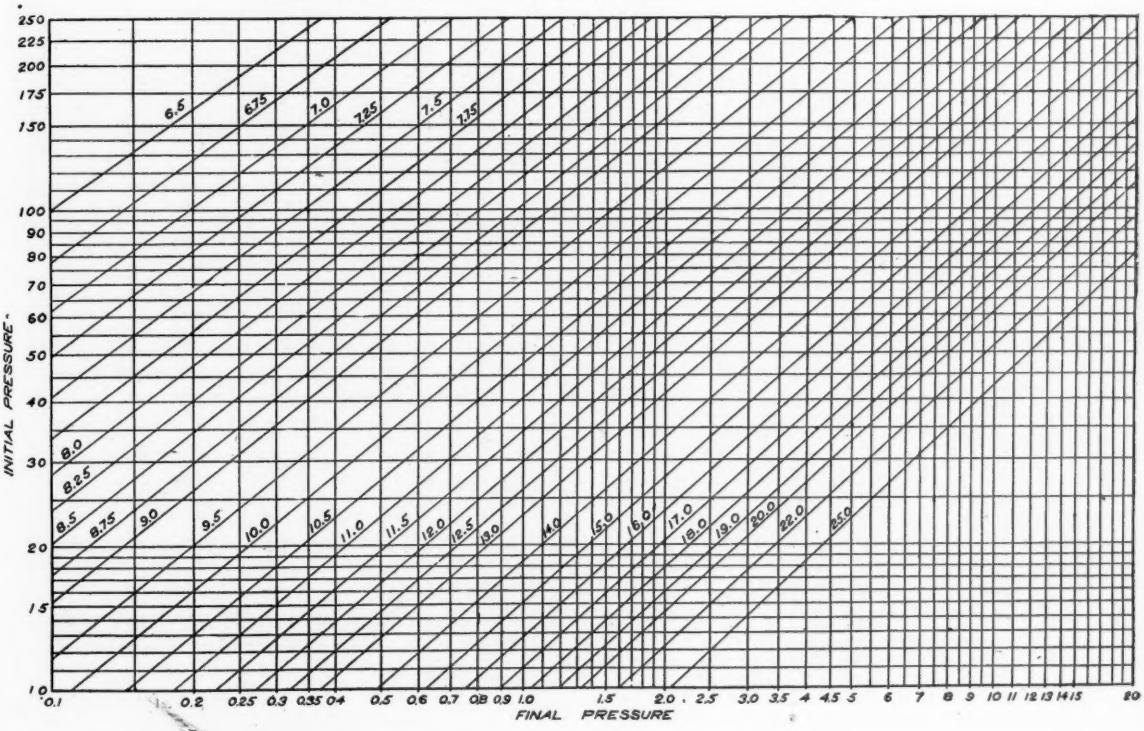
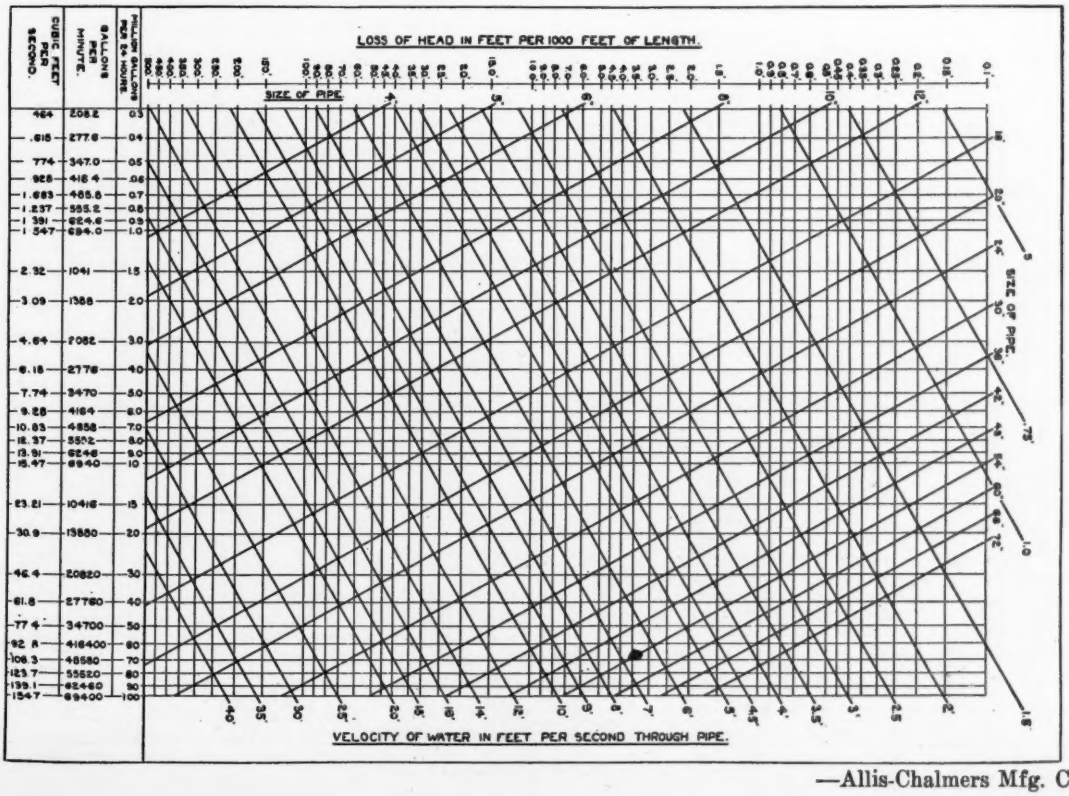
POWER PLANT ENGINEERING

DIAGRAM FOR DETERMINING THE STEAM CONSUMPTION OF A PERFECT ENGINE.



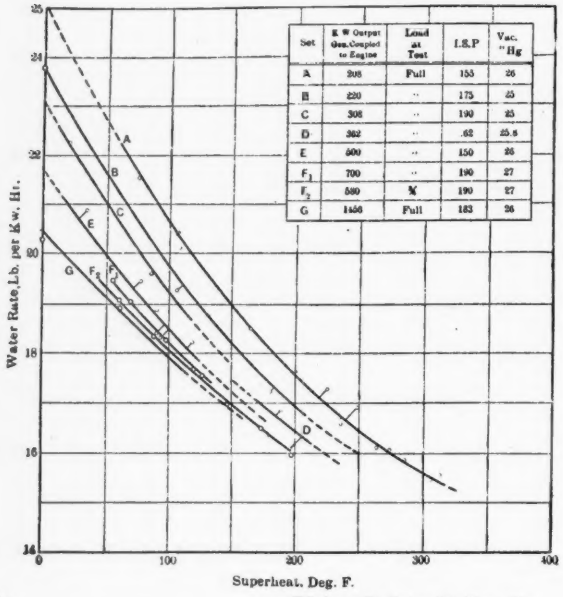

POWER PLANT ENGINEERING

FRICTION LOSS AND VELOCITY OF WATER IN PIPES



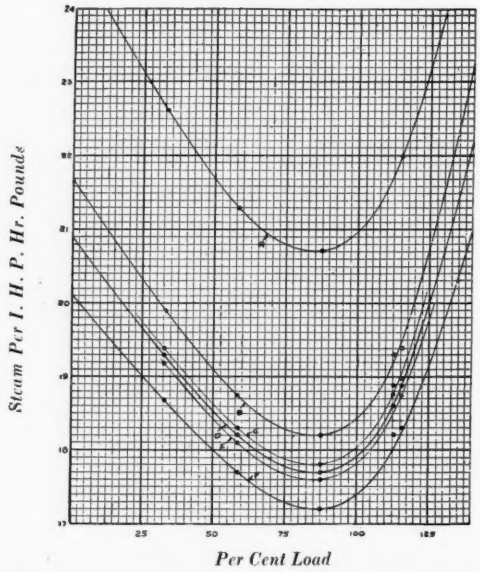

—Allis-Chalmers Mfg. Co.

WATER RATE OF CONDENSING ENGINES WITH VARYING DEGREES OF SUPERHEAT


Set | K W Output Gen. Coupled to Engine | Load at Test | I.S.P | Vac. "Hg
A | 308 | Full | 155 | 26
B | 220 | " | 175 | 25
C | 308 | " | 190 | 25
D | 362 | " | 62 | 25.8
E | 500 | " | 150 | 26
F1 | 700 | " | 190 | 27
F2 | 580 | ¾ | 190 | 27
G | 1456 | Full | 183 | 26
Water Rate, Lb. per K.w. Hr.
Superheat, Deg. F.

—Heine Safety Boiler Co.

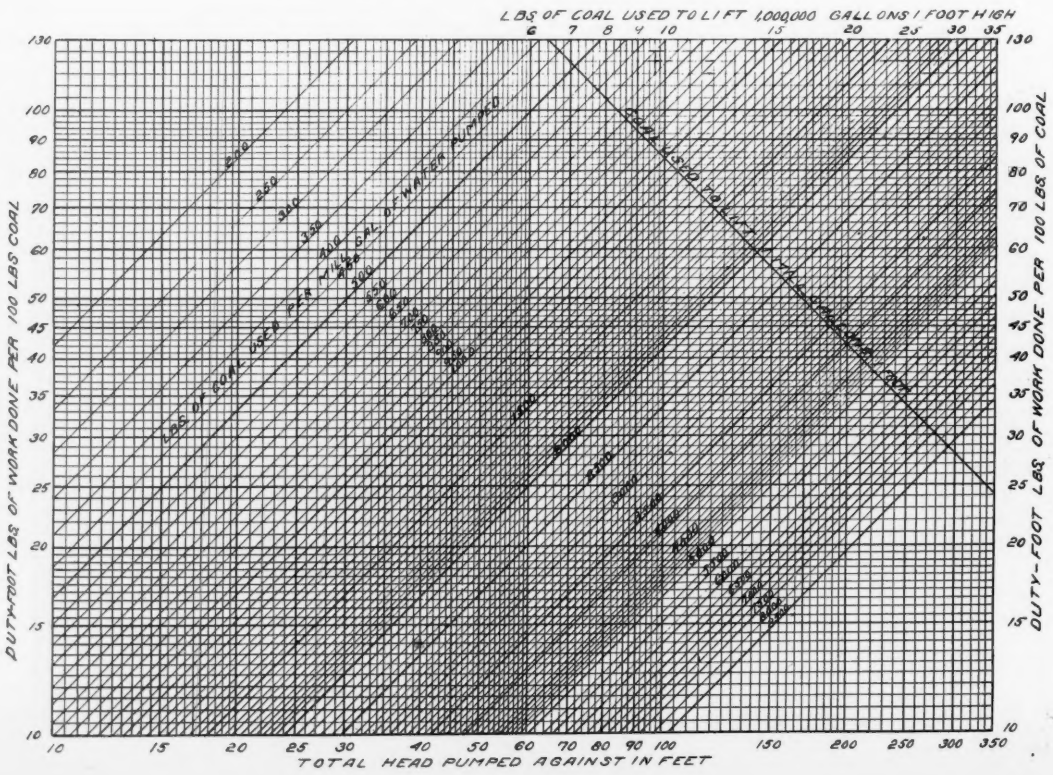
STEAM CONSUMPTION OF POPPET VALVE ENGINE WITH SUPERHEATED STEAM




Curve A, Dry Steam; B, 100-deg. Superheat; C, 120-deg. Superheat; 4, 125-deg. Superheat; E, 130-deg. Superheat; F, 150-deg. Superheat.

—Heine Safety Boiler Co.

DUTY OF AND COAL REQUIRED FOR PUMPING ENGINES


LBS OF COAL USED TO LIFT 1,000,000 GALLONS 1 FOOT HIGH
DUTY-FOOT LBS OF WORK DONE PER 100 LBS COAL
DUTY-FOOT LBS OF WORK DONE PER 100 LBS OF COAL
TOTAL HEAD PUMPED AGAINST IN FEET

Ferrochem machine permits minute particles of the metal to be continuously abraded and to circulate in the water before it enters the boilers. The salts and minerals deposit as a harmless sludge or mud that is easily washed out or blown out.

It is claimed that no chemicals are used, either in the manufacture of the machine or in its operation, and that the water and steam are not contaminated, permitting their use for any purpose. It is also claimed that there is no electrolytic action and that there is nothing in its use that will injure the boiler or its fittings.

The machine is the product of The Ferrochem Co., Ltd., New York City.

# News Notes

JENKINS BROTHERS, of New York, are to furnish the valves through the Hotel Commonwealth, which is shortly to rise 28 stories in Times Square district of New York City.

ONE EXAMPLE of successful helpfulness in war work is the raising, by the employes of the Westinghouse Electric & Mfg. Co., of $1,610,000 of subscriptions for the second Liberty Loan. The employes' organization set out with the goal to raise a million and a half dollars of subscriptions for these bonds, and succeeded in passing the goal by $110,000. It is interesting that, in connection with this bond subscription, out of approximately 30,000 employes, 22,000 subscribed to the bonds.

W. O. RENKIN, who for some years past was Chief Engineer of the A. M. Byers Co., of Pittsburgh, has resigned from that company to act in the capacity of Manager of the Engineering Department of the Quigley Furnace Specialties Co., 26 Cortlandt St., New York City, who specializes in powdered coal installations. Previous to going with the A. M. Byers Co. Mr. Renkin spent some years as Resident Engineer in charge of the organization and construction of the works and town of Sakchi, Bengal, India, for the Tata Iron & Steel Co.

WILLIAM A. BATTEY, who has been connected with the Shepard Electric Crane & Hoist Co. since its start in this field, as eastern sales manager and sales director, will sever his active connection with the business on Dec. 1, but will retain his interest in the company and continue as a director.

Mr. Battey, who is vice-president of the Pennsylvania Crusher Co., finds it necessary to devote his entire attention to its rapidly expanding business in the manufacture of hammer pulverizers, Bradford breakers and special crushing machinery for the by-product coke industry and other industries requiring reduction apparatus.

W. C. Briggs, who for the past 10 yr. has been associated with Mr. Battey in the Shepard Company's New York office as sales engineer, will become district manager.

On Nov. 1, Robert T. Turner will join the New York organization as sales engineer and as additional salesman and service man will shortly be located in the company's new offices at 30 Church St.

A SERIES OF EXPERIMENTS, started in 1910, to determine the effects of storage upon the properties of bituminous coal has recently been completed by the Engineering Experiment Station of the University of Illinois. The object has been to devise methods of storing which will avoid the risk of spontaneous combustion and to determine the extent to which coal deteriorates in storage.

Professor S. W. Parr, under whose direction the tests have been conducted, summarizes the results in Bulletin No. 97 of the Engineering Experiment Station. It is shown that, if properly sized and carefully handled, coal may be stored without danger of spontaneous combustion; that the actual loss of heat value, or deterioration, resulting from storage is slight; and that underwater storage eliminates entirely all risk of spontaneous combustion or of deterioration. The extent of the waste and economic loss incident to the present method of seasonal production, with its attendant abnormal demands upon transportation facilities is discussed, and it is estimated that the lack of storage facilities in large distributing centers necessitates a capital investment in mines and railroad cars of $500,000,000 in excess of the amount which would be required if production could be maintained at a uniform rate throughout the year.

Copies of Bulletin 97 may be had without charge by addressing C. R. Richards, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

# Catalog Notes

A NEW CIRCULAR and leaflet from Farnsworth Co., Conshohocken, Pa., illustrates systems and layouts wherein condensate is handled under conditions existing in the average power and heating plant, with a view to effecting a saving of coal by the method of feeding condensate into the boiler under full boiler pressure. The leaflet shows the temperatures of the condensate under the several conditions; as it is leaving the several types of traps, when it is being received into the boiler feeder and when it is being fed into the boiler.

THE GENERAL ELECTRIC CO. has prepared for distribution Bulletin 45,606, describing choke coils for alternating-current circuits for indoor, outdoor and line suspension service. An extremely important feature in the design of the G. E. coil is the air insulation between turns; also, being made of copper, it presents a very good appearance, conforming to the general appearance of strength and stability characteristic of the modern power plant. Interesting information and valuable data pertaining to choke coils for alternate-current circuits will be found on pages 4 and 8 inclusive in this bulletin.

STRATTON STEAM SEPARATORS Bulletin 1108 of The Griscom-Russell Co., 90 West St., New York, discusses reasons for using separators, compares centrifugal with baffle-plate separation and explains the construction and installation of the Stratton separator.

BULLETIN NO. 860, just received from The Leeds & Northrup Co., of Philadelphia, illustrates and explains the principle and manner of using the Leeds & Northrup optical pyrometer, a portable instrument for works temperature measurements.

SNOW OIL PUMPS are illustrated and described in Bulletin S-112, recently issued by Worthington Pump & Machinery Corporation, 115 Broadway, New York.

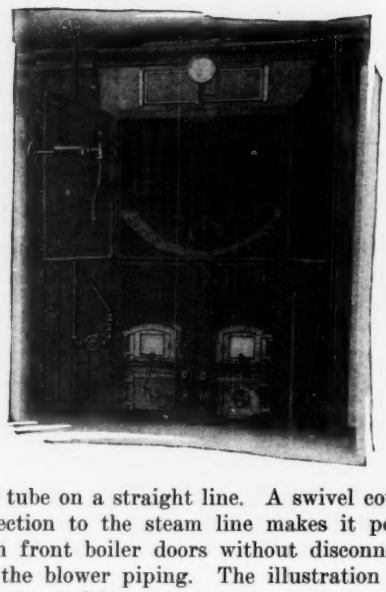
GENERAL ELECTRIC CO.'S Bulletin No. 46,030 gives description, illustrations and price lists of portable instrument transformers.

STEAM SPECIALTIES Catalog 21 contains price lists of steam traps, strainers, copper ball floats, exhaust pipe heads, valves, pressure regulators, pumps, governors, suction tees, water lifters and steam separators made by W. D. Allen Mfg. Co., of Chicago.

FROM CROUSE-HINDS CO., Syracuse, N. Y., we have received Bulletin No. 1D, supplement to panel and cabinet Bulletin No. 1, on the subject of safety panels and cabinets, accompanied by discount sheet now effective.

## Trade Notes

DIAMOND SOOT BLOWERS have recently been ordered by the United States Government to equip the boilers installed for heating and refrigerating purposes in the first American Cantonment in France. These are of Model "F" front end type, with a revolving arm carrying Diamond Venturi nozzles, which shoot a jet of steam into each tube at a velocity of about 2800 ft. a sec. The swinging of the arm throws a jet of steam directly



into each tube on a straight line. A swivel coupling in the connection to the steam line makes it possible to open both front boiler doors without disconnecting or cracking the blower piping. The illustration herewith shows the type of blower used.

AN ORDER for electric hoisting equipment from the Nevada Consolidated Copper Co. for its mine at Ruth, Nev., calls for a 400-hp. Westinghouse Type Cw wound-rotor induction motor and complete control equipment, comprising a Westinghouse liquid controller with necessary electro-magnetic switches. The hoist is to raise a load of 12,000 lb. of ore every 86 sec. through a distance of 720 ft.


# POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

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About nine words make a line. Minimum space sold, two lines.

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**Technical Publishing Co.**

537 S. Dearborn Street

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### Position Wanted

POSITION WANTED—By engineer with 11 years' experience in 325 hp. plant. Married. Steady and sober. Would like to get day work in Illinois. Address Box 497, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 11-15-1

POSITION WANTED—By young man as oiler in large central station, with 7 years' experience with Corliss engines up to 400 hp., d.c. generator. I. C. S. graduate on complete Steam Engineering. Age 27. Married. Best of reference. Will go any place. Address Box 493, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 11-15-1

POSITION WANTED—As helper or oiler in small or large plant. Will come at once. Sober and industrious. Will consider reasonable salary. Address Box 494, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-1-3

POSITION WANTED—By young man as oiler or assistant engineer in or around Chicago, with chance of advancement. Eight years' experience; ready to start work at a week's notice; references. Address Box 492, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 11-1-2

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 10-15-2

POSITION WANTED—By practical engineer of 15 years' experience. Am familiar with a.c. and d.c. generators and motors, also refrigerating machinery. Am 38 years old, married and strictly sober. Good references. E. W. Jones, Genl. Del., Metropolis, Ill. 11-15-1

POSITION WANTED—Will represent some engineering firm in Mexico or take a position as chief engineer. Can operate electric, ice or power plant. Can speak, read and write Spanish. Am practical and progressive engineer. Will consider only well rated concern. Am colored. C. D. Bassett, Engineer, 183 N. Wabash Ave., Chicago, Ill. 9-15-2

POSITION WANTED—By young man as engineer in power plant. Seven years' experience in gas works and small central station operating. A-1 references. Present salary $1,300. Married. Age 25. Address Box 490, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-15-2

POSITION WANTED—As chief engineer by middle-aged man, with 20 years' experience; famliiar with a.c. and d.c. generators and motors; also absorption refrigerating machinery and steam heating. Married and strictly sober. Present salary $1500. In present position 7 years. Desire change. Good reference. A. J. Marshall, Plainfield, Ind. 10-15-1

POSITION WANTED—As engineer or oiler in power or ice plant. Have had 15 years' experience. Fred J. Waite, 659 Douglas Ave., Aurora, Ill. 10-15-1

POSITION WANTED—By a licensed operating engineer with 5 years' experience. At present employed, but would like to make a change and locate in or near Philadelphia. Will consider position as operating or chief engineer at $150 per month. Can furnish best of references from present employer. Address Horace D. Ferrell, Box 501, Marcus Hook, Pa. 10-15-1

POSITION WANTED—Chief engineer desires change of location. Competent to handle large plant. Experienced with a.c. and d.c. machinery, irrigating machinery, ammonia compressors (practical ice-maker), gas engines and air compressors. Can install and do repairs. Not liable to conscription. Address Box 495, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 10-15-1

## Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

## Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chi-

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

## For Sale

FOR SALE—3 400-hp., Heine type, watertube boilers, with Murphy stokers, 2 yrs. service, 160-lb Hartford Insurance, $15 per hp.; 4 250-hp. Heine, 150-lb Hartford, $10 per h.p.; 2 150-hp. Babcock Wilcox, 160-lb. Hartford, $10 per hp.; 4 150-hp. return tubular, 125-lb. Hartford, $1,000 each. Power Machinery Exchange, Jersey City, N. J. tf.

AIR COMPRESSOR FOR SALE—10 and 20 steam, 12 and 12 air, all 10-inch stroke, Ingersoll-Sargent 450 feet free air, excellent order, $1,000 f.o.b. Federal Electric Welding Co., Baltimore, Md. 11-15-2

MACHINERY FOR SALE—One twin cylinder 60-hp. Gas Engine, d.c. to 30-kw. General Electric generator. Also one 22½-kw. belted generator switchboard, one air pump, two air tanks and fittings and gas regulator. All in good condition. Address Room 606, 202 N. 9th St., St. Louis Mo. 11-15-1

## Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

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PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

INVENTORS, ATTENTION!—Practical patents developed—financed—promoted—for our members. Write for details. Inventors Co-operative Bureau, Lankershim Bldg., Los Angeles, Cal. tf

ADVICE ON PATENTABLE IDEAS—Confidential electrical and mechanical information furnished to investors at low rates by expert engineers. We send on receipt of your inquiry our guarantee giving absolute protection of your ideas. Investigate our offer. Sandborn & McKaig, Engineers, 172 W. 86th St., New York City. 11-1-2

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## Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes with back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

# Sparks From The Advertising Pages

## The Value of Good Will in Business

Good will is essential to good business. Therefore, the manner of creating good will in business is worthy of earnest consideration. Nothing can create good will so surely and permanently as good advertising. Advertising not only establishes an element of good will in business, but reduces the cost of production and distribution as well. The man who disputes the value of advertising and good will in business is fast disappearing from the industrial world.

An investigation of the business of the man who says advertising does not pay, invariably discloses the fact that the fault lies in his merchandising methods, the quality or price of his goods, or lack of knowledge of consumer demand, or something that could have been avoided at the outset.

The manufacturer who advertises and establishes an element of good will with his prospects, values it too highly to allow anything to occur which would in any way injure his reputation for fair dealing and dependable merchandise. The buying public is quick to recognize this and feels a sense of safety in dealing with such manufacturer.

A manufacturer has two methods of creating good will and a market for his product. He can reach the consumer through a huge force of salesmen, or he can use a smaller number of salesmen and supplement their efforts with intelligent advertising. The latter method is by far the safest and most economical way, because the consumer becomes acquainted with the nature and merit of the product offered before the salesman calls and is more likely to give him an audience.

Quantity buying, manufacturing and selling is not so easily achieved by the non-advertiser. The non-advertiser is generally the first to raise prices. He has no good will to maintain—his responsibility to the consumer is less. It will be noticed that nationally advertised goods have, during these days of increasing prices, maintained their old prices or increased them in small proportion only to those of unbranded, unadvertised products.

The advertisers in POWER PLANT ENGINEERING value highly the good will of its readers, and are ready to assist you in the selection of efficient machinery, equipment and supplies for your power plant, and if you will write to them they will gladly send you their catalogs and other literature.